



Center for Occupational Health & Safety Engineering  
THE UNIVERSITY OF MICHIGAN

**NIOSH Training Grant No. T42 OH 008455**

**THE UNIVERSITY OF MICHIGAN  
CENTER FOR OCCUPATIONAL HEALTH  
& SAFETY ENGINEERING: A NIOSH  
EDUCATION AND RESEARCH CENTER**

**ANNUAL REPORT  
July 1, 2006 – June 30, 2007**

**SUBMITTED BY:  
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CENTER DIRECTOR  
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**(November 1, 2007)**

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## **II. Introduction and Executive Summary**

July 2006 through June 2007 was a highly productive year for our ERC. In the sections below we list the major accomplishments and significant changes during the year. We also provide information about our ERC website, which we are now in the process of updating.

### **II.A. Major Accomplishments**

#### **Enrolled students**

- From July 1, 2006 to June 30, 2007, 85 students were enrolled in ERC related programs, including 43 full-time Masters level students, 7 part-time Masters level students, and 35 Ph.D. students.
- 29 of the 85 enrolled students were NIOSH supported trainees, including 32 full-time Masters students, 1 part-time Masters student, and 4 Ph.D. students.

#### **Graduated students**

- A total of 34 students graduated from ERC academic program areas, including 17 MPH students, 3 Ph.D. students in Industrial Hygiene, 2 MS Nursing students, 5 MS Engineering students, 7 Ph.D. students in Industrial and Operations Engineering.

#### **Publications and presentations involving trainees**

- NIOSH supported trainees produced or collaborated on a total of 98 publications and presentations during the reporting period.

#### **New faculty hires/faculty augmentation of specific programs**

- Our faculty in occupational epidemiology has been dramatically augmented by 3 new faculty, and a high degree of integration with the department of epidemiology has been achieved.
- There were four faculty hired into the EHS Department in 2005, including a new Chair, all of whom are now having positive impacts on the IH Program. Two additional faculty member was hired in Fall, 2006: Marie O'Neill (Asst. Prof., 50% apt., started in September, 2006) who brings expertise in environmental exposure assessment and epidemiology, and Sung Kyun Park, Sc.D., Research Assistant Professor of Environmental Health Sciences. We also successfully recruited and hired Prof. Nil Basu (Asst. Prof., started in September 2007) who brings expertise in exposure biomarkers.
- Dr. Hu, the new Chair of EHS, became the Occupational Epidemiology Program Director on July 1, 2007.
- We have also added, from the Department of Epidemiology, Dr. Soliman, an expert in occupational cancer epidemiology, and Dr. Mary Haan, an expert in aging and epidemiology has been collaborating on studies of occupational health in aging workers. Finally, we have added faculty from the Department of Biostatistics, Assistant Professor Bhramar Mukherjee, an expert in gene-environment interactions, and Research Assistant Professor Brisa Sanchez, an expert in structural equation modeling.
- Professor Emeritus Don Chaffin retired from faculty service at the end of 2006. However, he remains very active in ongoing research projects and continues to chair several dissertation committees.
- Professor Gary Herrin completed his service as Dean of Undergraduate Education in the College of Engineering, and has resumed a full-time academic appointment in

IOE. This will allow him to return to a normal load of teaching and supervising student research.

- Dr. Omer Tsimoni, an Assistant Research Scientist at the U of M Transportation Research Institute, has joined the IOE faculty as an Assistant Professor. He teaches our course on Simulation (IOE 474) and serves on several dissertation committees in the area of cognitive ergonomics.

### **Faculty promotions**

- One Program Director (Dr. Hong in OHN) was promoted from Assistant Professor to Associate Professor with Tenure

### **Retooled programs**

- The non-residential On Job/On Campus (OJ/OC) Executive Masters program, intended for mid-career professionals in industrial hygiene, occupational health nursing, occupational medicine, and occupational safety engineering, was reformulated into a mixed modality (half of face-to-face and half distance learning) program to (successfully) increase enrollment while maintaining rigorous quality. Enrollment is now 16. Beginning with the 2006 cohort, a formal lab course was incorporated into the OJ/OC curriculum (EHS-653, *Environmental Sampling and Analysis Lab*, 1 credit-hour).

### **Pilot projects**

- Four new pilot projects in NORA research areas were funded during July 2006 through June 2007
- Since the program's inception:
  - Seven pilot project trainees have accepted new positions as faculty members in academic institutions.
  - Two pilot project trainees have accepted new research positions in private sector laboratories.
  - One patent disclosure has been filed.

### **Trainee awards and honors**

- A total of 16 awards and honors were bestowed upon ERC trainees since July 2006, including 4 of the 12 nationally awarded ASPH/EPA Fellowships, 1 National Science Foundation Graduate Fellowship, 3 AIHF Awards, 1 Tichauer Award for best student presentation at the AIHCE, and multiple University of Michigan School of Public Health scholarships
- Our students have received a number of awards over the past year, including: AIHF George and Florence Clayton Endowed Scholarship Award, Gustavo Serrano; AIHF Ralph Smith Endowed Scholarship Award, Pamela Dopart; AIHF Michigan IH Society Scholarship, Jennifer Hsu, MIHS Award, Matthew Johnson; 2006 EHS MPH Poster Competition, 1<sup>st</sup> Place – Joseph Moralez, Honorable Mention – Hollie Quisenberry and Ryann Fischer; Warren Cook Award, Aaron Sussell.
- A recent graduate (Clark) won the award from the ABOHN for the highest score in the case manager certification examination in 2007.
- Four of our OSE Ph.D. students (Michael Bauerly, Marc Berman, Thomas Ferris, and Suzanne Hoffman) were honored as NSF Graduate Fellows.
- Mr. David Wagner won a College of Engineering Outstanding Graduate Mentor Award for excellence in supervision of undergraduate research.
-

## Faculty awards and honors

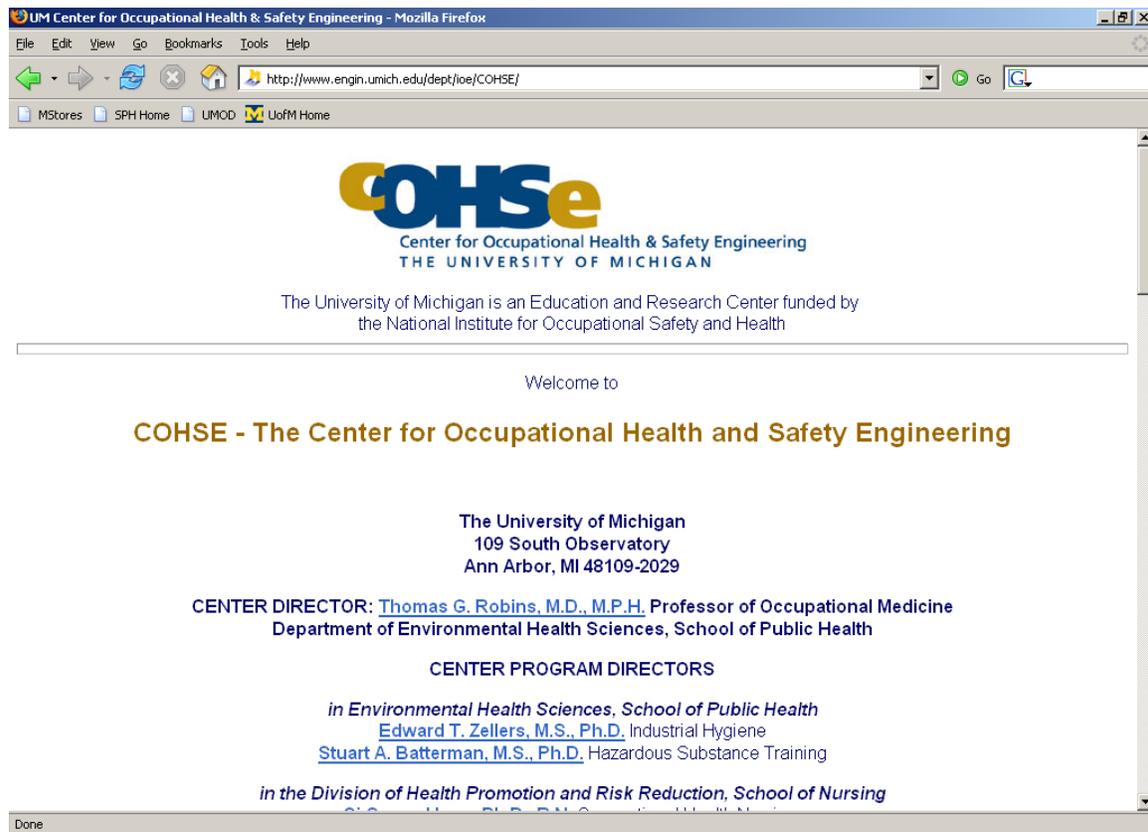
- Numerous ERC related faculty were recognized for their outstanding teaching and research in the field with awards, including the Jon R. and Beverly S. Holt Award for Excellence in Teaching, the Blue Cross Blue Shield of Michigan Foundation Excellence in Research Award in the category of Health Policy or Health Services Research, the Excellence in Research Award from the University of Michigan School of Public Health, and the Young Clinic Investigator Award.
- ERC related faculty were honored for their achievements in the field through serving on National Research Council Committees, receiving a joint appointment as Professor of Civil and Environmental Engineering in the College of Engineering, being selected as an AAOHN Fellow, serving as President of Midwestern Nursing Research Society, and presenting the keynote address at the Eurosensors XIX conference.
- The IH program assembled and submitted a Self Study Report, and went through a site visit as part of its effort to receive re-accreditation by the American Board of Engineering and Technology (ABET). The site visit was held in October, 2006 and went extremely well. Re-accreditation was awarded in July, 2007.
- Professor Zellers delivered invited talks at the PCIH, Pittcon, and Transducers '07 concerning his research on microanalytical systems for airborne contaminants. His joint appointment as Professor of Chemistry was renewed for another 5 years. Professor Meeker became a CIH in October, 2007.
- **Professor Franzblau** was honored in January 2007 by giving the keynote address to a meeting in South Africa on interpretation of radiographs for pneumoconiosis. **Professor Garabrant's** work on meta analysis of mesothelioma risks to motor vehicle mechanics was noted as a major work on asbestos fiber toxicity in the Annals of Occupational Hygiene commentary on achievements over the past 10 years. Professor Garabrant received the Excellence in Research Award from the University of Michigan School of Public Health in April 2006. This award is made annually to a single faculty member in recognition of outstanding research accomplishments. **Professor Hu** received the 2006 Harriett Hardy Award from the New England College of Occupational and Environmental Medicine, became, in 2007, a member of the Board on Population Health and Public Health Practice of the Institute of Medicine, National Academies of Science, and in May of 2007 became the first holder of the NSF International Endowed Chair of Environmental Health Sciences at the University of Michigan School of Public Health. **Professor O'Neill** was elected to a 3 year term as a Councilor for the International Society for Environmental Epidemiology. **Professor Meeker** was awarded the Young Clinical Scientist Award from the Flight Attendant Medical Research Institute for 2005-09. **Professor Haan** has been responsible for reforming the EPID MPH curriculum, publishing in Nature and in the Neurobiology of Aging.
- Prof. Don Chaffin received the 2007 Arnold M. Small President's Distinguished Service Award from the Human Factors and Ergonomics Society.
- Prof. Yili Liu received the 2006-07 Jon R. and Beverly S. Holt Award for Excellence in Teaching.
- Prof. Thomas Armstrong served on the ACGIH Physical Agents Committee.
- Profs. Don Chaffin, Monroe Keyserling, and Nadine Sarter served on National Research Council Committees.
- Adjunct Prof. Paul Adams served as Vice President of the Board of Certified Safety Professionals.

### **Continuing Education and Outreach activities**

- 20 courses were conducted through Continuing Education and Outreach (CEO) during the reporting period, including 6 IH courses, 8 OHN courses, 2 OMR courses, and 4 OSE courses, with a total of 1067 persons trained.
- During the reporting period, CEO exhibited at 7 professional conferences, including the Human Factors and Ergonomics Society, American Industrial Hygiene Association, American Society of Biomechanics, Applied Ergonomics Conference, International Ergonomics Association and the American Association of Occupational Health Nursing conferences.
- We maintain a 5500+ member email listserv system to reach large numbers of individuals via e-mail quickly and inexpensively. We use this outreach tool to inform many people about our ERC activities and to recruit students via a monthly announcement. We maintain a Michigan ERC Web site to provide visitors with academic and continuing education information and we field Web site-related telephone and internet inquiries, providing ad-hoc service to individuals in a wide variety of organizations.
- The University of Michigan conducts a sizable training and service project for small businesses in Michigan. This project, funded by a Consultation, Education and Training (CET) grant from the state of Michigan is led by Michigan ERC faculty and staff from the College of Engineering. This outreach activity assists a state agency, Michigan OSHA, by providing on-site ergonomics training to approximately 200 people annually (not included in CE course attendee counts). This project also provides state employers with professional service to identify high-risk workplaces and to assist in developing systems to reduce the risk of musculoskeletal injuries. This project is a valuable resource to Michigan OSHA staff who provide support to regional companies beyond our direct contact. This on-going project has reached more than 2900 people in on-site seminars and over 6000 people via CD-ROM training. NIOSH budget is not used directly for these activities, but the infrastructure provided by the ERC grant is instrumental in obtaining the CET grant.

## II. C. ERC Web site

Representative pages from the University of Michigan ERC Web site and key links to other related sites are shown below. Related links include those to faculty members associated with the Center, Center academic program areas, the Center's continuing education program, faculty interests, Ph.D. thesis topics. These links connect the Center to the major contributors at the University and to the collaborating University departments and programs. We are launching a plan to update the entire UM ERC site. This will include an updated research section, a student and alumni section, photos and slideshow of trainees and faculty, and the inclusion of the external advisory board members.



**Home page:** <http://www.engin.umich.edu/dept/ioe/COHSE/>

### **Links to faculty:**

Center Director: <http://www.sph.umich.edu/iscr/faculty/profile.cfm?username=trobins>

IH Program Director:

<http://www.sph.umich.edu/iscr/faculty/profile.cfm?username=eellers>

HSAT Program Director:

<http://www.sph.umich.edu/iscr/faculty/profile.cfm?username=stuartb>

OHN Director: [http://www.nursing.umich.edu/faculty/hong\\_oisaeng.html](http://www.nursing.umich.edu/faculty/hong_oisaeng.html)

OSE Director: <http://ioe.engin.umich.edu/people/fac/wmkeyser.php>

OE Director: <http://www.sph.umich.edu/iscr/faculty/profile.cfm?username=howardhu>

**COHSE Academic Degree Programs:**

<http://www.engin.umich.edu/dept/ioe/COHSE/#CAD>

IH Program: <http://www.sph.umich.edu/ehs/ih/>

HSAT Program: <http://www.sph.umich.edu/hsat/>

OHN Program: <http://www.nursing.umich.edu/academics/masters/ohn.html>

OSE Program: <http://www.engin.umich.edu/dept/ioe/COHSE/OSE.html>

OE Program: <http://www.sph.umich.edu/ehs/oe/>

**COHSE Continuing Education Program:**

<http://www.engin.umich.edu/dept/ioe/COHSE/#CEP>

Current Schedule of Course Offerings:

[http://www.engin.umich.edu/dept/ioe/COHSE/pro\\_ed\\_calendar.html](http://www.engin.umich.edu/dept/ioe/COHSE/pro_ed_calendar.html)

Ergonomics Training and Service for Small and Medium Sized Michigan

Companies: [http://www.engin.umich.edu/dept/ioe/C4E/erg\\_training.html](http://www.engin.umich.edu/dept/ioe/C4E/erg_training.html)

Needs Assessment Survey: <http://www.zoomerang.com/recipient/survey-intro.zgi?p=WEB223UYHWQP96>

**Faculty and Their Major Interests:**

Center faculty page: <http://www.engin.umich.edu/dept/ioe/COHSE/fac.html>

EHS faculty page: <http://www.sph.umich.edu/iscr/faculty/dept.cfm?deptID=2>

OHN faculty page: <http://www.nursing.umich.edu/faculty/index.html>

OSE faculty page: <http://ioe.engin.umich.edu/people/fac/Areas.pdf>

**Ph.D. Thesis Topics:** <http://www.engin.umich.edu/dept/ioe/COHSE/phd.html>

**Related Links:**

University of Michigan Rehabilitation Engineering Research Center:

<http://umrerc.engin.umich.edu/>

University of Michigan Center for Ergonomics: <http://www.engin.umich.edu/dept/ioe/C4E/>

NIOSH: <http://www.cdc.gov/niosh/homepage.html>

OSHA: <http://www.osha.gov/>

## Example of faculty page

UM SPH Faculty Profile for Howard Hu - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.sph.umich.edu/iscr/faculty/profile.cfm?uniqname=howardhu

SPH Home UMOD UofM Home eResearch - Universi...

**M SPH** University of Michigan School of Public Health

SEARCH  Go! Departments and Programs  Go!

SPH HOME DIRECTORY CONTACT US UM HOME

[UM SPH Home](#) > [Faculty & Research](#) > [Environmental Health Sciences Faculty Profiles](#) > Howard Hu

**Faculty & Research**

**Faculty Profiles**

- [BIOSTAT](#)
- [EHS](#)
- [EPID](#)
- [HBHE](#)
- [HMP](#)

**Faculty Research Projects**

**Research Centers & Initiatives**

**Resources for Faculty**

**Faculty & Staff Directory**

**HIPAA**

■ ■ ■ Site Menu



**Howard Hu, M.D., M.P.H., Sc.D.**

**Chair, Environmental Health Sciences**

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109 South Observatory  
Ann Arbor, Michigan 48109-2029

Office: (734) 764-3188; Fax: (734) 936-7283

E-mail: [howardhu@umich.edu](mailto:howardhu@umich.edu)

Website(s): [Metals Epidemiology Research Group](#) ;  
[Curriculum Vitae](#)

**Professional Summary**

Dr. Hu is a physician board-certified in internal medicine and occupational/environmental medicine who also holds a doctoral degree in epidemiology. Until mid-2006, he was Professor of Occupational and Environmental Medicine at the Harvard School of Public Health, Director of the Harvard Residency Program in Occupational and Environmental Medicine, Director of the Harvard Metals Epidemiology Research Group, Director of the Center for Children's Environmental Health and Disease Prevention Research, Associate Director of the Harvard NIEHS Center and Associate Physician at the Channing Laboratory of the Brigham and Women's Hospital. He taught the main introductory courses in Environmental Health and Medicine at the Harvard School of Public Health for 16 years. On 9/1/06, Dr. Hu assumed the position of Chair of the Department of Environmental Health Sciences and Professor of Environmental Health, Epidemiology, and Medicine at the University of Michigan Schools of Public Health and Medicine. Dr. Hu continues his research on metals toxicity by co-directing, with Dr. Robert Wright, what is

**Table of Contents**

- [Professional Summary](#)
- [Courses Taught](#)
- [Education](#)
- [Research Interest & Projects](#)
- [Selected Publications](#)
- [Professional Affiliations](#)

Done

# Example of academic program page

UM SPH Department of Environmental Health Sciences - Programs and Degrees - Industrial Hygiene - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.sph.umich.edu/ehs/i/

MStores SPH Home UMOD UoM Home

**M SPH** University of Michigan School of Public Health

SEARCH  Go Departments and Programs  Go

SPH HOME DIRECTORY CONTACT US UM HOME

EHS Home > Programs and Degrees > Industrial Hygiene

## Industrial Hygiene

Environmental Health Sciences

**Programs and Degrees**

- Environmental Health
- Hazardous Substances
- Human Nutrition
- Industrial Hygiene
- Occupational & Environmental Epid
- Toxicology
- Executive Degree Programs

**Admissions & Financial Aid**

**Courses**

**Faculty**

**Research**

**Alumni**

**Careers**

**Information & Resources**

**Contact Information**

Each year, thousands of workers throughout the world are killed, injured, or otherwise adversely affected by chemical, biological, and/or physical, agents encountered in the workplace. Common hazards include dusts, gases and vapors, bio-aerosols, pathogens, noise, and ionizing and non-ionizing radiation. Ergonomic stresses and safety hazards are also important causes of workplace morbidity and mortality. The goal of our graduate program is to educate individuals to anticipate, recognize, evaluate, control, and manage such workplace health risks.



The Industrial Hygiene (IH) Program at the University of Michigan (UM) is one of the longest-standing and most highly regarded IH Programs in the country. Graduates from our program have gone on to leadership positions in private industry, government, and academia in the U.S. and throughout the world.

**EXPLORE**

- [IH Home page](#)
- [Admissions](#)
- [Students](#)
- [Alumni](#)
- [Financial Aid](#)
- [Relevant Links](#)
- [Degree Options](#)
- [Research](#)
- [Kudos](#)
- [Career Opportunities](#)
- [Faculty](#)
- [Newsletters](#)
- [Continuing Education](#)

Done

## Example of Continuing Education

2006 University of Michigan COHSE Continuing Education Programs Calendar - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.engin.umich.edu/dept/ioe/COHSE/pro\_ed\_calendar.html

MStores SPH Home UMOD UofM Home

**COHSE**  
Center for Occupational Health & Safety Engineering  
THE UNIVERSITY OF MICHIGAN

**2006 - 2007 Continuing Education Programs**

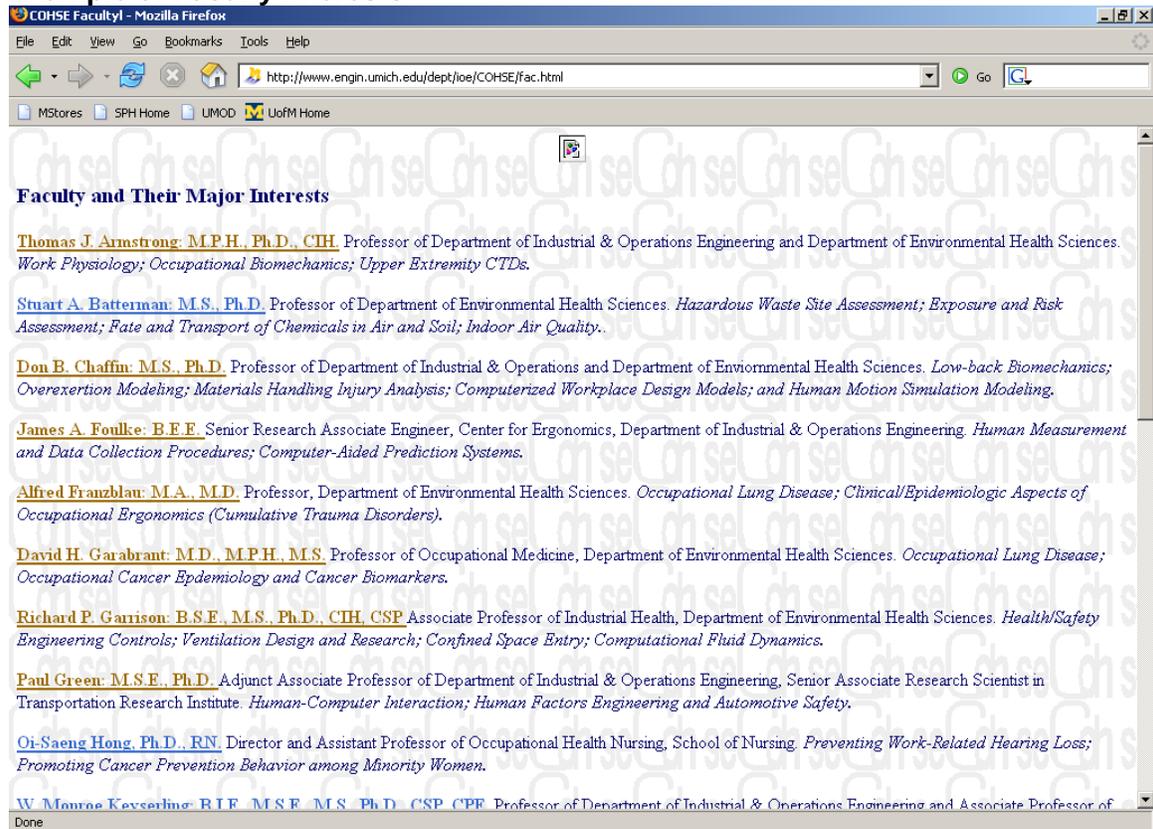
Help us plan for new 2006 - 2007 program offerings using our on-line **Needs Assessment Survey**

We issue periodic e-mail announcements about upcoming programs and activities. If you would like to be included on this distribution list, please click **Subscribe** and "send" the automatically generated e-mail message. (If clicking on this link does not automatically issue an e-mail message from your account, manually issue an e-mail message to [cohse-ce-request@umich.edu](mailto:cohse-ce-request@umich.edu) and include "subscribe" in the subject line.)

Ongoing	<a href="#">On-line Training Opportunities for Occupational Physicians and Others</a> <a href="#">Ergonomics Training and Service for a Limited Number of Small and Medium Sized Michigan Companies</a>
	<p><b>If you are here to register online for a course click on course below.</b></p> <p>Online registration available for select courses only.</p>

Done

## Example of Faculty Interests



COHSE Faculty - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.engin.umich.edu/dept/ioe/COHSE/fac.html

MStores SPH Home UMOD UofM Home

### Faculty and Their Major Interests

**Thomas J. Armstrong: M.P.H., Ph.D., CIH** Professor of Department of Industrial & Operations Engineering and Department of Environmental Health Sciences. *Work Physiology; Occupational Biomechanics; Upper Extremity CTDs.*

**Stuart A. Batterman: M.S., Ph.D.** Professor of Department of Environmental Health Sciences. *Hazardous Waste Site Assessment; Exposure and Risk Assessment; Fate and Transport of Chemicals in Air and Soil; Indoor Air Quality.*

**Don B. Chaffin: M.S., Ph.D.** Professor of Department of Industrial & Operations and Department of Environmental Health Sciences. *Low-back Biomechanics; Overexertion Modeling; Materials Handling Injury Analysis; Computerized Workplace Design Models; and Human Motion Simulation Modeling.*

**James A. Foulke: B.E.E.** Senior Research Associate Engineer, Center for Ergonomics, Department of Industrial & Operations Engineering. *Human Measurement and Data Collection Procedures; Computer-Aided Prediction Systems.*

**Alfred Franzblau: M.A., M.D.** Professor, Department of Environmental Health Sciences. *Occupational Lung Disease; Clinical/Epidemiologic Aspects of Occupational Ergonomics (Cumulative Trauma Disorders).*

**David H. Garabrant: M.D., M.P.H., M.S.** Professor of Occupational Medicine, Department of Environmental Health Sciences. *Occupational Lung Disease; Occupational Cancer Epidemiology and Cancer Biomarkers.*

**Richard P. Garrison: B.S.E., M.S., Ph.D., CIH, CSP** Associate Professor of Industrial Health, Department of Environmental Health Sciences. *Health/Safety Engineering Controls; Ventilation Design and Research; Confined Space Entry; Computational Fluid Dynamics.*

**Paul Green: M.S.E., Ph.D.** Adjunct Associate Professor of Department of Industrial & Operations Engineering, Senior Associate Research Scientist in Transportation Research Institute. *Human-Computer Interaction; Human Factors Engineering and Automotive Safety.*

**Oi-Saeng Hong, Ph.D., RN** Director and Assistant Professor of Occupational Health Nursing, School of Nursing. *Preventing Work-Related Hearing Loss; Promoting Cancer Prevention Behavior among Minority Women.*

**W. Monroe Keyserling: B.I.E., M.S.E., M.S., Ph.D., CSP, CPE** Professor of Department of Industrial & Operations Engineering and Associate Professor of

Done

## Example of Ph.D. Thesis topics



Doctoral Dissertations - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.engin.umich.edu/dept/ioe/COHSE/phd.html

MStores SPH Home UMOD UofM Home

Ph.D. Thesis Topics Since 1980. Copies of these dissertations may be ordered online from [ProQuest Information and Learning](#), or by calling +1-734-761-4700

- W. Park, 2003. *Memory Based Human Motion Simulation*
- L. Brixie, 2003. *The Development of a Rapid Testing Method for Personal Aerosol Samplers*
- C. Godwin, 2003. *Indoor Air Quality and Human Health and Comfort in Large Mechanically Ventilated Office Buildings: Longitudinal Studies*
- M. Hsieh, 2003. *An Investigation of Polymer-Coated Surface-Acoustic-Wave Microsensor Arrays for the Determination of Organic Solvent Vapors*
- M. Jeebhay, 2003. *Occupational Allergy Associated with Saltwater Bony Fish Processing in South Africa*
  
- C. Lu, 2002. *Portable Analytical System Employing Tunable Separation and Microsensor Array Detection for Indoor Air Quality Monitoring*
- M. Marshall, 2002. *Development of Models and Procedures for Evaluating Hand Exertion during Manual Work*
- N. Nithiseelan, 2002. *Respiratory Health of South African Coal Miners*
  
- R. Feyen, 2001. *Modeling Human Performance Using the Queuing Network-Model Human Processor (QN-MHP)*
- [S]A. Luehman, 2001. *Factors Affecting Secondary Science Teachers' Appraisal and Adoption of Technology-Rich, Project-Based Learning Environments*
  
- S. Kalampakorn, 2000. *Stages of Construction Workers Use of Hearing Protection*
- J. Park, 2000. *A Personal Direct-Reading Instrument Employing a Surface-Acoustic-Wave Microsensor Array for the Measurement of Organic Vapor Exposures*
  
- C.C. Caruso, 1999. *Gastrointestinal Problems in Auto Factory Workers*
- M.M. Homan, 1999. *Evaluation of Exposure Assessment and Diagnostic Methodologies for Use in Epidemiological Studies of Work-Related Musculoskeletal Disorders*
- I.W. Huang, 1999. *Effects of Keyboards, Armrests, and Alternating Keying Positions on Subjective Discomfort and Preferences Among Data Entry Operators*
- M.C. McCullagh, 1999. *Factors Affecting Protector Use Among Farmers*
- K. Monroe, 1999. *Evaluation of Factors Influencing the Maintenance of Static, Non-seated Work Postures: Assessment of Age, Gender, Strength, and Flexibility*
- J. Park, 1999. *A Personal Direct-Reading Instrument Employing a Surface-Acoustic-Wave Microsensor Array for the Measurement of Organic*

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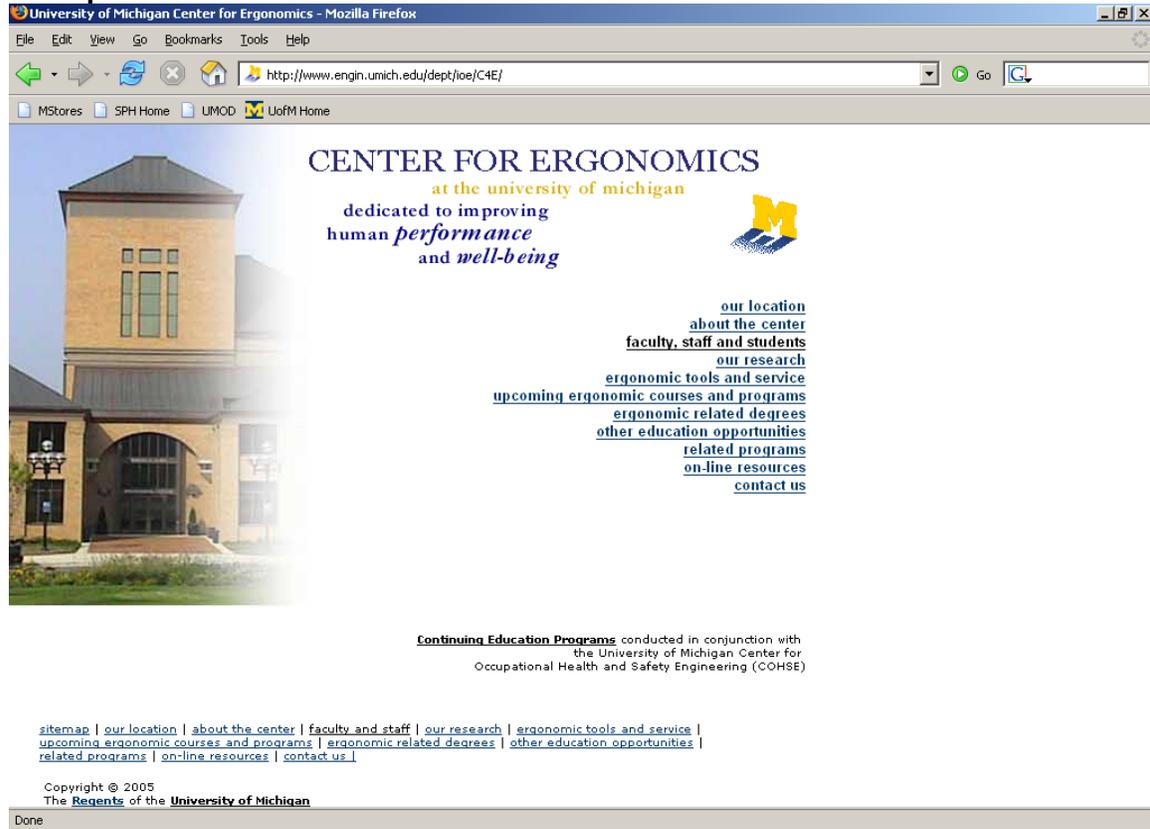
## Example of related link

University of Michigan Center for Ergonomics - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.engin.umich.edu/dept/ioe/C4E/

MStores SPH Home UMOD UofM Home



**CENTER FOR ERGONOMICS**  
at the university of michigan  
dedicated to improving  
human *performance*  
and *well-being*



- [our location](#)
- [about the center](#)
- [faculty, staff and students](#)
- [our research](#)
- [ergonomic tools and service](#)
- [upcoming ergonomic courses and programs](#)
- [ergonomic related degrees](#)
- [other education opportunities](#)
- [related programs](#)
- [on-line resources](#)
- [contact us](#)

**Continuing Education Programs** conducted in conjunction with  
the University of Michigan Center for  
Occupational Health and Safety Engineering (COHSE)

[sitemap](#) | [our location](#) | [about the center](#) | [faculty and staff](#) | [our research](#) | [ergonomic tools and service](#) | [upcoming ergonomic courses and programs](#) | [ergonomic related degrees](#) | [other education opportunities](#) | [related programs](#) | [on-line resources](#) | [contact us](#) |

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## **A. Program Title**

Center Administration

## **B. Program Director**

Thomas G. Robins, M.D., MPH  
Professor of Occupational and Environmental Medicine

## **C. Program Description**

### **C.1 Brief History and Goals**

The University of Michigan Center for Occupational Health and Safety Engineering (COHSE) was established as a NIOSH Education and Research Center (ERC) in 1982, and has been continuously funded since that time. As a NIOSH ERC, we currently provide professional (Masters) and research (Doctoral and post-Doctoral) training in Industrial Hygiene (IH), Occupational Health Nursing (OHN), and Occupational Safety Engineering and Ergonomics (OSE), Occupational Epidemiology (OE), and Hazardous Substances Academic Training (HSAT). Other components include a Pilot Project Research Training Program (PPRT), NORA Research Support Program (NORA), and Continuing Education and Outreach (CEO) programs. All programs are based at the Ann Arbor campus in our School of Public Health, School of Nursing, and College of Engineering, facilitating interdisciplinary activities for faculty and students.

*Mission Statement:* Our mission is to serve the region, nation, and world as a center of excellence for research and graduate education in Occupational Health and Safety. We will maintain outstanding academic and research programs in the disciplines of Industrial Hygiene, Occupational Health Nursing, and Occupational Safety Engineering and Ergonomics, and in Hazardous Substances Academic Training, and in Occupational Epidemiology. We will provide broad-based, interdisciplinary academic training in occupational health to ensure that graduates are qualified to pursue careers and assume leadership roles in the practice of occupational health and safety. We will offer a variety of continuing education programs and outreach activities to transfer state-of-the-art knowledge to professionals and practitioners in OH&S and allied disciplines.

As a NIOSH Education and Research Center, we serve a number of constituencies, including: 1) NIOSH, 2) industry, labor, and professional interests in our region, 3) academic units within the University of Michigan that provide critical teaching and research resources (including tenured faculty positions) necessary for Center success, and 4) our students. The broad goals of the Center are to:

- Increase the financial resources needed to improve the number, quality, and diversity of graduate students in each core area
- Promote excellence in our academic training and research training programs in each program area
- Enhance the quality of our Continuing Education courses and other service/outreach activities
- Increase external research funding in order to improve our research infrastructure and expand opportunities for research training
- Provide an organizational structure to coordinate and promote multidisciplinary educational activities for all core programs

- Promote OH&S education in undergraduate and graduate courses in other departments and other regional schools
- Assist Center programs and affiliated academic units in recruiting and promoting faculty associated with the Center.

## C.2. Center Management

Our Center is managed by an Executive Committee comprised of the Center Director, Associate Director, the five Academic Program Directors, and the Director of Continuing Education. This committee meets formally six or more times per year. Between formal meetings, there is regular communication through electronic mail, telephone calls, and personal interaction at seminars and other interdisciplinary activities.

Since July, 2001, Dr. Thomas Robins has served, as Center Director, and Dr. Monroe Keyserling has served as Associate Center Director. The directorships of the programs include Dr. Edward Zellers (IH), Dr. Monroe Keyserling (OSE), Dr. Violet Barkauskas (OHN), Dr. Howard Hu (OE), Dr. Stuart Batterman (HSAT& PPRT), Mr. Randy Rabourn (CEO), and Dr. Thomas Robins (NORA).

All activities of the Center are discussed routinely during the frequent Executive Committee meetings. In these meetings there is a strong emphasis on maximizing input of the Program Directors and striving for consensus to assure that the best decisions are taken. Important areas of Center management which the Executive Committee addresses include:

- Fiscal: preparation in the fall of budget requests for the Annual Progress Report and Non-competing Continuation Application; preparation in the spring of final budgets for the next fiscal year based on the NIOSH "Award Statement"; review of encumbrances and planned expenditures for the current fiscal year, and coordination of the request to NIOSH for "carry forward" funds (if any) from the previous fiscal year
- Grant applications: review of progress and setting of goals for the coming year including common themes and approaches
- Interdisciplinary interactions: interdisciplinary activities are planned for the new academic year (e.g., courses, seminars, clinics, field investigations, and social activities). Areas where interactions can be improved are identified and plans are made to enhance student and faculty interactions. Progress is reviewed at all meetings of the Executive Committee.
- Academic planning constitutes a major activity which includes: a) review of course offerings and time schedules to insure that students can register for courses taught outside of their own school; b) review of progress of students from all cores in multidisciplinary courses; c) plan our interdisciplinary seminar series; d) discussion and coordination of student recruiting activities; e) discussion of faculty recruiting in disciplines essential to the function of the ERC; f) development of plans for new and revised interdisciplinary courses; g) discussion of strategies for promotion of research in NORA priority areas and the best use of NORA research support funds; h) review of progress of the Pilot Project Research Training; i) discussion of Continuing Education/Outreach activities and goals to assure participation of faculty from all core disciplines; j) identification of research opportunities that promote interdisciplinary interactions among faculty and students.
- Setting future directions: we utilize each meeting of the Executive Committee to: a) monitor progress in achieving Center goals and meeting benchmark measures of effectiveness; b) discuss new directions in the occupational health and safety professions that need to be addressed in our training programs; c) plan responses to research funding opportunities that cut across the core disciplines; d) discuss changes at NIOSH, OSHA, and other federal and state agencies that may influence our training, research, and continuing education activities.

In addition to meetings of the Executive Committee, there are other activities that bring together Program Directors and faculty from all academic cores. The Center-supported weekly Seminar in Occupational Health and Safety Engineering (Winter Term) provides opportunities for all faculty to meet informally. Cross-departmental faculty appointments also provide opportunities for individual faculty members to promote and coordinate interdisciplinary OH&S teaching and research. Four such appointments exist for Profs. Armstrong, Chaffin, Franzblau, and Keyserling, who hold positions in both the EHS Department in the School of Public Health and the IOE Department in the College of Engineering.

The Center also benefits greatly from guidance by an External Advisory Board composed of representatives from five core disciplines. Members of the committee (see Figure) come from industry, labor and government. Meetings of the Advisory Board are held annually in the late fall. During the past grant cycle, two changes were made in the structure of these meetings which have substantially increased the specificity and usefulness of input from the Advisory Board: a) critical issues facing the Center (recent examples: student recruitment strategies, response to bioterrorism and the attacks of September 11, integration of distance learning modalities into curricula, response to expected trends in the occupational health and safety over the next five years) are discussed in small breakout groups mixing Board members and Center faculty followed by report back sessions to the full group; b) Board members go into closed executive session at the end of each meeting and then report recommendations back to the faculty. In addition to formal meetings, individual faculty are in regular contact with committee members to discuss specific issues of mutual interest.

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**FIGURE. ERC ADVISORY BOARD**

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**PAUL S ADAMS** PhD, CSP, CPE (*OSE*)  
Manager, Safety Engineering & Ergonomics  
EnSafe, Inc

**DOUGLAS KALINOWSKI** (*IH, OSE*)  
Director, Bureau of Safety and Regulation  
Consumer and Industry Services  
Michigan Department of Labor

**BEGNT ARNETZ**, MD, PhD, MPH, MSciEpi  
(*OE,*)  
Professor of Occupational and Environmental  
Medicine  
Dept of Family Medicine  
Wayne State University

**HENRY B. LICK**, PhD, CIH, CSP (*IH*)  
Consultant  
(Formerly Head of Industrial Hygiene at Ford  
Motor Company)

**TIM McCLAIN**  
Director, Health and Safety  
International Union, United Auto Workers

**DAVID K. MARTIN**, CIH (*IH, OSE, CE*)  
EHS Manager  
Xpedx

**PAUL D MOSS**, CIH, ROH (*IH*)  
Director, Corporate Health, Safety & Env.  
Dade Behring, Inc

**HENRY PAYNE**, PhD, CIH (*IH, CEO*)  
Director  
OSHA Training Institute

**DEBORAH DIBENDETTO**, MBA, RN, COHN-  
S/CM, ABDA, FAAOHN (*OHN*)  
PRESIDENT, DVD ASSOCIATES

**MARYJEAN SCHENK**, MD, MPH, MS (*OEE*)  
Associate Professor & Chair  
Dept of Family Medicine  
Wayne State University

**FREDERICK M. TOCA**, PhD, CIH, CSP (*IH*)  
Industrial Hygienist  
Atlantic Environmental Inc

**JUDY MORRIS**, RN, MS, COHN-S/CM (*OHN,*  
*CE*)  
Manager, EH&S  
Attwood Corp

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#### **D. Program Activities and Accomplishments**

Over the past year, the ERC has made excellent progress towards its goals and objectives. Major accomplishments in the areas of trainee honors, awards, scholarships; faculty honors, awards, appointments; trainee theses and dissertation; new faculty positions; new and modified courses; and trainee recruitment including diversity efforts are presented in section II.A. Major Accomplishments. Significant changes in the ERC are described in section II.B. Significant Changes since July 1, 2005-June 30, 2006. In Section IV Specific Improvements in Occupational Safety and Health Resulting From ERC Programs, we report on further accomplishments involving the translation of research and training activities into improved OHS practice.

#### **E. Program Products**

Key products of the ERC are listed in Section II.A. together with Section IV.

#### **F. Future Plans**

Our overall goals for the next 5-year period include: 1) maintaining excellence in all academic programs, 2) development of new sources of financial support for trainees, 3) continuing curriculum refinement and improvement, 4) growth in our On Job/On Campus programs in IH and OHN, 6) maintaining the excellence and size of our CE programs through new courses and

improved linkages with professional organizations and, 7) establishment of two new Targeted Research Training programs: Pre-Doctoral Research and Research to Practice.

Some notable elements of our future plans include:

- Improve strategic planning:
  - Continue to make significant use of our talented and interested external advisory board to assist with detailed strategic planning for the ERC. To accomplish this we have increased our meeting schedule from annually to semiannually, and include a half day retreat jointly between ERC faculty and External Advisory Board members to help plan future directions and initiatives.
- We will continue to recruit, enroll, and graduate the most talented students and future leaders of the field in our Masters and doctoral programs. We will pursue several strategies to further increase our success with recruitment including:
  - We have created and widely advertised a new NORA Fellowship to attract and support the most talented doctoral students wishing to carry out research in NORA related areas
- Continue to make improvements our curricular offerings, and in the interdisciplinarity of the of training of our students. These improvements will include:
  - Continue to offer our new interdisciplinary management course;
  - Continue to offer our new interdisciplinary team-based course organized around the conduct of OHS research and practical projects
- Enhance research training through a combination of:
  - Continued funding of pilot projects;
  - Direct funding of NORA-related research projects in which students are involved
  - Having faculty continue to aggressively pursue competitive research funding in which students will participate;
- Recruit and involve new faculty in our ERC programs:
  - An active search is underway for a new senior faculty member in OHN;
  - Markedly increasing the involvement of faculty with primary appointments in the Department of Epidemiology in our occupational epidemiology training programs
- Continue to aggressively pursue the scheduling of continuing education programs and outreach activities

## **A. Program Title**

Interdisciplinary Coordination

## **B. Program Director**

Thomas G. Robins, M.D., MPH

Professor of Occupational and Environmental Medicine

## **C., D., and E. Program Description, Program Activities and Accomplishments, Program Products**

### **C.1. Student Interaction in Scheduled Classes and Seminars**

The Center is strongly committed to interdisciplinary education. As part of this commitment, we believe that students from different disciplines should share classroom experiences, and we have designed our curricula accordingly. Students from the different ERC programs take six common didactic courses (also attended by students outside of the ERC): 1) EHS 550: *Industrial Hygiene*, 2) IOE 539: *Occupational Safety Engineering*, 3) EPID 503: *Strategies and Uses of Epidemiology*, 4) EHS 658: *Physical Hazards in the Work Environment*, and 5) IOE 837/EHS 668: *Occupational Health and Safety Seminar*. 6) Beginning in January 2007, we have added a new course NUR 606 *Management for Occupational & Environmental Health and Safety Professionals* that is led by the OHN faculty. The course will be offered by OHN faculty along with guest speakers in various fields (IH, occupational safety engineering, business, etc) starting. This will be the first course taught by OHN faculty for students in other OHS programs. This course will be required for IH, HSAT, OSE, OHN, and OM (in OJ/OC) students.

With the addition of a new interdisciplinary course to the curriculum (see Future Directions section below), this will bring us to 7 courses taken by all students for 14 credit hours. This schedule assures that on-campus, full-time students from all cores will be together in at least two classes every semester. On Job/On Campus (OJ/OC) students in IH, OM, OSE, thisand OHN also take these courses together during their weekends on campus. Finally, we are able to bring all OJ/OC students and on-campus students together during the Winter Term for the Seminar in Occupational Health and Safety Engineering.

In addition to the above courses that are common to all four cores, students from two or more cores routinely take the following courses: Biostat 503 Introduction to Biostatistics (IH, OE, OHN, HSAT), EHS 501 Occupational Diseases (IH, OE, OHN, HSAT), EHS507 Exposure Assessment (IH, OE, HSAT), EHS 508 Risk Assessment (IH, OE, HSAT), EHS 654 Ventilation for Contaminant Control (IH, EH, OSE), EHS 757 Occupational Health Aspects of Industrial Processes (IH, OSE), Epid 501 (Principles of Epidemiology (IH, HSAT, OE, OHN), IOE 433 Ergonomics (IH, OSE), IOE 439 Safety Management (IH, OSE), IOE 534 Occupational Biomechanics (OSE, IH), IOE 634 Work-related Upper Limb Disorders (OSE, IH).

### **C.2. Interdisciplinary Interaction in Student Research and Projects**

There are many opportunities for students from different cores to work together outside of the classroom. In the Occupational Health Aspects of Industrial Processes course (EHS 757), students conduct plant walk-throughs together as members of an interdisciplinary team. In Occupational Diseases (EHS 501), Exposure Assessment (EHS 507), and Risk Assessment (EHS 508) students work together on team projects and formal presentations that require integration of knowledge from across the cores

Students also have an opportunity to interact with students and faculty from outside their core discipline when performing research projects. Some examples include contributions of Drs. Tom Armstrong in Occupational Safety Engineering, and Al Franzblau in Occupational Epidemiology to research activities for three of the OHN doctoral students by serving on the preliminary exam and dissertation committee; service on the doctoral committees of SPH students by Occupational Safety Engineering faculty (Drs. Armstrong and Keyserling), and service by Dr. Franzblau in SPH on doctoral committees of students in Industrial and Operations Engineering. This coordination also helps to maximize participation of faculty from outside of Center core programs with the research of doctoral students in core programs. Examples

include participation of faculty in the Department of Epidemiology and in the Medical School on doctoral research of Occupational Epidemiology students, and faculty in Electrical and Mechanical Engineering, Chemistry, and Physics interacting with Industrial Hygiene doctoral students. The NORA Research Support Program and the Pilot Project Research Training Program provides additional opportunities for student involvement in interdisciplinary research through support of several research projects which bring together students and faculty from different programs.

Students in the On Job/On Campus program have a unique opportunity for interactions outside their core disciplines, which include industrial hygiene, occupational health nursing, occupational safety engineering, and occupational medicine. Not only do these students participate together in classes once every two months over almost 2 years during the “on-campus” weekend; they also interact regularly with professionals from other occupational health and safety disciplines during their regular work assignments. These “on-the-job” experiences are shared in the classroom and informally during the on-campus weekends.

### C.3. Interdisciplinary Interactions beyond the ERC Cores

Faculty from the ERC core programs also interact on a regular basis with other groups on campus by presenting guest lectures and seminars, participating in clinics, committee service, and as co-investigators on research projects. Students from the ERC cores are frequently active participants in these endeavors. Departments, centers, institutes and clinics involved in interdisciplinary research include: The School of Architecture, The School of Natural Resources, The Department of Aerospace Engineering, The Department of Biomedical Engineering, The Department of Electrical Engineering and Computer Science, The Department of Mechanical Engineering and Applied Mechanics, The Department of Chemistry, The Department of Neurology, The Department of Neuropsychology, The Department of Physical Medicine and Rehabilitation, The Department of Endocrinology, The Program in Kinesiology, The Institute of Gerontology, The Kresge Hearing Institute, The Institute for Social Research, The University of Michigan Cancer Center, The Center for Integrated Sensor Circuits, The University of Michigan Hospitals Health Program Advisory Committee, The University of Michigan Advisory Committee on Health Affairs, The University of Michigan Advisory Committee on Laboratory Safety.

## F. Future Plans

1. In September 2007, we launched a completely restructured version of a course, EHS 600, currently titled Professional Perspectives in Environmental Health. This 2-credit course will be required of all students in all ERC-associated programs, both residential and OJ/OC, including IH, OHN, OSE, HSAT, OE, and OM (in OJ/OC). Students form working teams from multiple disciplines on the project that draw upon their disciplinary perspectives to characterize or solve a practical research or other type of problem. The leaders of the Employee Health and Evaluation and Control of Occupational and Environmental Hazards units in the University of Michigan Health System work with ERC faculty and the student groups to define, provide resources to address, and co-supervise the solution of important OHS issues they face. Groups work under the supervision of ERC faculty members whose interests are matched to the type of problem selected by the group. We consider this new course to be a key mechanism for increasing high quality interdisciplinary interaction across students from all of the disciplines represented in the ERC, as well as between residential and OJ/OC students. These interdisciplinary team projects may be particularly illuminating for residential students, as they are teamed with OJ/OC students who are mid-career professionals with substantial levels of practical knowledge and experience in the solution of real-life OHS problems.
2. We have arranged to have all Center students be eligible for an interdisciplinary field trip: a well-established "toxic tour" of the city of Detroit led by the Executive Director of Detroiters Working for Environmental Justice, Ms. Donele Wilkins, who has long-

standing interest in both occupational and environmental health issues and strong ties with several of our Center faculty including the Center Director, Dr. Robins.

3. An opportunity has been created for interested all Center students, especially OHN, as well as IH and OSE students, and occasional OE and HSAT students, to rotate through clinical employee health services and occupational medicine sites, where they would have the opportunity to interact with board-certified, highly experienced occupational medicine physicians, i.e., either Dr. Susan Blitz at the UMHC Employee Health Service or Dr. Daniel Chapman and Dr. Deborah Heaney, at the UM affiliated MWorks clinic which services a wide range of employer clients. All three are highly experienced, board-certified in occupational medicine, and graduates of our Center's OM residency. The length of such a rotation, and whether it would be for academic credit or on a "volunteer" basis, could be modified to meet the needs of the Center student.
4. Systematic evaluation of the quality and impact of these new interdisciplinary elements through surveys and/or interviews of participating students and faculty, and make adjustments as needed. Interdisciplinary coordination will be included as a standing item of our frequent Center Executive Committee meetings to help insure that any needed corrections or new ideas can be implemented in a timely fashion.

## **Pilot Project Research Training Progress Report:**

### **A. Program Title**

The University of Michigan Center for Occupational Health and Safety Engineering,  
Pilot Project Research Training Program

### **B. Program Director**

Stuart Batterman, M.S., Ph.D.

Professor of Environmental Health Sciences, School of Public Health

Professor of Civil & Environmental Engineering, College of Engineering

### **C. Program Description**

#### *C.1 Goals*

The goal of Pilot Project Research Training Program (PPRT) is to strengthen the future occupational health and safety research capacity of the United States by increasing the number and quality of scientists who pursue research careers in occupational health and safety (OH&S) disciplines. This is accomplished by enhancing opportunities for research training at The University of Michigan's Center for Occupational Health and Safety Engineering (UM-COHSE) and at other colleges and universities in our region. Specifically, the PPRT Program provides short-term seed funds to support innovative pilot research projects in priority areas defined by the National Occupational Research Agenda (NORA) and for projects that address special OH&S needs in HHS Region V, the manufacturing heartland of the United States.

This project supports the following types of University of Michigan research trainees:

1. Ph.D. students enrolled in ERC core and component programs;
2. Junior faculty and post-doctoral research fellows and affiliated with ERC core and component programs, and;
3. Ph.D. students, post-doctoral fellows, and/or junior faculty in non-core programs who wish to develop or enhance their OH&S research capabilities.

In addition, support is provided for pilot research projects and collaborative research with faculty and students from NIOSH Training Project Grants (TPGs) and other colleges and universities in HHS Region V. At these institutions, support is provided to the following types of research trainees:

1. Ph.D. students enrolled in TPG programs;
2. Junior faculty and post-doctoral research fellows affiliated with TPG programs, and;
3. Ph.D. students, post-doctoral fellows, and/or junior faculty at institutions without NIOSH TPG training grants who wish to develop or enhance their OH&S research capabilities. (For example, our pilot project grant has supported students and faculty in the Mechanical, Biomedical, and Industrial Engineering Departments at The University of Wisconsin at Madison.)

#### *C.2 Responsible Conduct of Science Training*

The University of Michigan (UM) is committed to the responsible conduct of faculty, staff, and students in all aspects of research. As part of this commitment, UM has established a web-based system for training and certifying faculty, staff, and students on responsible research practices. Faculty, staff and students who serve as investigators or research assistants must complete modules on: 1) Foundations of Responsible Research Conduct (e.g., ethics and legal requirements related to publication/authorship, intellectual property, conflict of interest, plagiarism, misconduct reporting, etc.); and 2) Human Research (e.g., why human subjects

research is regulated, regulatory and ethical responsibilities of the PI, IRB and University, etc.). Each module includes a test which must be successfully passed in order to achieve certification. The website for the training program can be accessed at <http://www.research.umich.edu/training/peerrs.html>.

In addition to the formal certification process, students work closely with faculty mentors to develop research protocols, write informed consent documents, prepare IRB applications and collect data on human subjects. Most Masters-level trainees and all Doctoral-level trainees play a significant role in submitting at least one complete IRB application in conjunction with the research projects required for their degree.

All projects that involve the participation of human subjects must be reviewed and approved by a University of Michigan Institutional Review Board (IRB) or by the IRB of the applicant's institution. To comply with NIOSH pilot project guidelines for protection of human subjects, IRB approval documents for each project are submitted to NIOSH with the request to release funds. UM has very extensive procedures, including web-based training, that can be accessed at <http://www.eresearch.umich.edu>.

Should any project involve the use of vertebrate animals, recombinant DNA, radioisotopes, and/or radioactive materials, approval is required from the appropriate committee(s) at the applicant's institution before funds are released to the investigators.

### *C.3 Program Faculty*

The University of Michigan Center for Occupational Health and Safety Engineering is fortunate to have a large faculty with strong research records that cover a broad spectrum of OH&S issues. These faculty serve as advisors and sponsors for internal pilot research projects and as liaison representatives for collaborative projects with regional institutions. Faculty sponsors and their areas of research expertise are shown in Appendix [PPRT-1](#).

## **D. Program Activities and Accomplishments**

### *D.1 Announcing the Competition for Funding*

To provide research trainees and faculty advisors adequate time to prepare proposals, the formal announcement of the Pilot Project Research Training Program (PPRTP) is distributed each spring for the pending budget year. These announcements are sent to faculty and students in all University of Michigan ERC programs, to NIOSH TPG Project Directors in HHS Region V, and to other regional colleges and universities with OH&S research activities. A copy of the announcement distributed for the 2006-07 budget year is presented as [Appendix PPRT-2](#).

### *D.2 Scientific Review Process*

Proposals are evaluated by the Pilot Research Project Scientific Review Committee. Current committee members include:

- Stuart Batterman, Ph.D., Hazardous Substances Academic Training Program
- W. Monroe Keyserling, Ph.D., Occupational Safety/Ergonomics Academic Program
- Sally Lusk, Ph.D., Occupational Health Nursing Academic Program
- Alfred Franzblau, M.D., Occupational Medicine/Occupational Epidemiology Academic Programs
- Edward Zellers, Ph.D., Industrial Hygiene/Hazardous Substances Academic Programs
- John Graff, Ph.D., Regional Academic Representative, Wayne State University (Epidemiology)

- Lida Orta-Anes, Ph.D., Public Representative, United Auto Workers and The University of Puerto Rico (Ergonomics and OHS programs)
- Paul S. Adams, Ph.D., External Advisory Board Representative, Applied Safety and Ergonomics Inc. (Safety Engineering and Management)

Proposals are distributed to members of the Scientific Review Committee for a mail-ballot review. Each proposal is scored on a 100-point quality scale using the scoring sheet shown in Appendix [PPRT-3](#).

#### *D.3 Progress During Reporting Year*

For the reporting year (July 2006 – June 2007), 5 proposals were submitted and 4 were funded. We have now funded 31 Pilot Projects (see Appendices for a complete list). Titles, NORA areas and performance sites for the 2006-7 funded projects are summarized below:

1. Microbial Characterization of Metal Removal Fluids and Associated Biofilms Using Molecular Approaches.  
 NORA Areas: Infectious Diseases, Indoor Environments, Exposure Assessment Methods, Asthma and Chronic Obstructive Pulmonary Disease  
 Performance Site: University of Michigan (Industrial Hygiene)
2. Post-doctoral Training in Exposure Assessment of Emerging Contaminants in the Indoor Environment  
 NORA Areas: Indoor Environments, Exposure Assessment Methods  
 Performance Site: University of Michigan (Industrial Hygiene)
3. Development of a Biomechanical Model for Torque and Thrust Strength on Cylindrical Handles  
 NORA Areas: Musculoskeletal Disorders of the Upper Extremity, Traumatic Injuries  
 Performance Site: University of Michigan (Occupational Safety and Ergonomics)
4. Modeling the Relationship between Work-related Musculoskeletal Disorder Risk Exposure and Lean Manufacturing  
 NORA Areas: Musculoskeletal Disorders of the Upper Extremity, Organization of Work  
 Performance Site: University of Michigan (Occupational Safety and Ergonomics)

Additional information on these projects, including abstracts and budgets is given in Appendix [PPRT-4](#).

#### *D.4 Progress in Regional Collaboration*

During the eight years (July 1999 – June 2007) of the NIOSH pilot project initiative, we have had excellent participation from regional institutions, with almost one-third of all projects (9 out of 31) awarded to collaborating schools, including: The University of Wisconsin (six projects); Purdue University (two projects); and Wayne State University (one project). Within the University of Michigan, three pilot projects have been performed outside the core academic programs of our ERC, including: two projects in Physical Medicine and Rehabilitation, and one project in Emergency Medicine.

#### *D.5 Program Evaluation*

The ERC Executive Committee reviews the program annually. Our review includes the following topics:

- Number of internal and external proposals submitted. For the past three years (2005-07 reporting year and current year), we had fourteen internal and three external proposals submitted. (Note: One of the internal proposals was the re-submission of an unfunded project.)
- Number of funded proposals and funding “success” rate. For the past two years, we funded nine of 10 proposals (90 percent success rate).
- Amount and source of matching funds to support pilot research projects. This amount is typically 50-60% of the total project cost and includes items such as cost sharing of equipment purchases and payment of trainee tuition.
- Publications and presentations from funded projects. 22 new publications were produced or reported during the 2006-07 cycle. See Appendix [PPRT-5](#).
- New proposals generated based on pilot project findings. 4 new proposals were generated since our last progress report. See Appendix [PPRT-5](#).
- Placement of research trainees in academic, public sector and private sector research positions. New appointments among recent grant recipients occurring during the reporting year included:
  - Dr. Charles was appointed as Assistant Professor of Environmental Health Sciences at the Jiann-Ping Hsu College of Public Health, Georgia Southern University in Statesboro, GA.
  - Dr. Oisaeng Hong has been promoted to Associate Professor, School of Nursing, The University of California, San Francisco, CA.

## **E. Program Products**

The major products resulting from the PPRT Program can be grouped into three major categories: (1) Publications (includes publications in archival journals, publications in conference proceedings, and oral presentations at professional/research meetings); (2) Proposals developed as a result of Pilot Project research activities; and (3) Placement of Pilot Project trainees in research positions in academia, government and the private sector. Since the inception of the Pilot Project Research Training Project in 1999, our grant has been quite successful, producing the following outputs:

- Pilot project research projects have resulted in a total of 77 publications and/or oral papers.
- 13 proposals that were seeded by pilot project research have been funded.
- An additional eight proposals seeded by pilot project research have been prepared; seven were not funded and two are awaiting a funding decision.
- Eight pilot project trainees have accepted new positions as faculty members in academic institutions.
- Two pilot project trainees have accepted new research positions in private sector laboratories.
- One patent disclosure has been filed.

## **F. Future Plans**

Five pilot projects have been approved for the 2007-08 budget year:

1. Adaptation of a Novel Portable GC to the Determination of Breath Biomarkers of Lung Cancer

NORA Areas: Indoor Environments, Exposure Assessment Methods, Cancer Research Methods

Performance Site: University of Michigan (Industrial Hygiene)

2. Noise, Lead and Age-Related Hearing Loss

NORA Areas: Hearing Loss, Indoor Environments, Exposure Assessment Methods, Mixed exposures.

Performance Site: University of Michigan (Occupational Epidemiology)

3. Pilot Project Research Training in Emission and Permeation Characteristics of Biofuels: Potential for Worker Exposure

NORA Areas: Indoor Environments, Exposure Assessment Methods

Performance Site: University of Michigan (Hazardous Substances Academic Training)

4. High Resolution Breath Monitoring of VOC Mixtures

NORA Areas: Exposure Assessment Methods, Mixed Exposures

Performance Site: University of Michigan (Hazardous Substance Academic Training)

5. Controlling Power Hand Tool Reaction Through Mechanical and Electronic Torque Control

NORA Areas: Musculoskeletal Disorders of the Upper Extremity

Performance Site: University of Wisconsin (Occupational and Safety Engineering)

Additional information on these projects, including abstracts and budgets is given in [Appendix PPRT-6](#).

## **A. Program Title**

Nora Research Support

## **B. Program Director**

Thomas G. Robins, M.D., MPH  
Professor of Occupational and Environmental Medicine

## **C. Program Description**

### **C.1 Goals and Objectives**

The overarching goal of the NORA Research Support program is to enhance the ERC's research training mission in an integrated fashion across the disciplines represented in the Center. Our ERC research training programs are designed to promote high quality research in the NORA research priority areas. We emphasize the development of the interdisciplinary research skills among students needed to become future leaders in occupational health and safety research. This interdisciplinary focus allows the complex issues raised by several of the NORA priority areas to be addressed effectively by graduates of our programs. Some of the elements which are emphasized in the NORA Research Support program include: 1) the development and delivery of research-related courses and continuing education using distance learning modalities, 2) funding of guest speakers with expertise in NORA-related research areas to give presentations and collaborate with University of Michigan faculty and students, 3) the sponsorship of conferences and symposia to assess regional needs for research and research training, 4) support of pilot research training projects on NORA related topics, 5) direct support of doctoral students conducting research in NORA priority areas, and 6) leveraged support of new research faculty and major research equipment playing a critical role in technical research support and training of graduate students with a NORA focus.

## **D. and E. Program Activities, Accomplishments, and Products**

### **D.1. Assessing and meeting regional research needs.**

The NORA Research Support program contributes in several ways to the ERC's effort to assess and meet regional research needs.

The sponsorship of conferences and symposia to assess regional needs for research and research training. A series of annual symposia on long-standing and emerging NORA-related research issues and needs were held at the Michigan Safety Conference and very well-attended.

Periodic survey of the rich pool of ERC alumni holding professional positions in occupational health and safety. The ERC used NORA support funds to analyze results of a previous comprehensive survey of alumni during the past 20 years using a combination of mailings and a dedicated internet site. Questions were included concerning the adequacy of specific courses addressing research issues, as well as the extent to which degree programs offered under the ERC enable practicing occupational safety and health professionals to translate research findings into interventions to prevent illness and injury and the workplace. NORA funds were used to design a new set of discipline-specific alumni survey instruments including an additional direct focus on NORA-related research needs, and to pilot the new survey instrument among the industrial hygiene alumni. An ERC-wide alumni survey redesigned on the basis of this pilot was conducted in the 2006-2007 fiscal year.

## D.2. Provision of administrative and technical research support.

Administrative research support. The Center Director, Dr. Thomas Robins, the Associate Center Director, Dr. W. Monroe Keyserling, and the Center Administrative Assistant, Ms. Emily MacGuire, received salary funding under the NORA research support program to provide administrative research support for the Center. Their activities include 1) working with the individual program directors and other ERC faculty to develop goals and long range plans for NORA-related research funding, 2) fiscal planning, reviewing and coordinating budgets, and overseeing accounting functions, 3) organizing Executive Committee Meetings for oversight of these NORA-related activities, with an emphasis on ensuring interdisciplinary research approaches involving faculty and students across the Center.

Technical research support. A critical addition to our Center's ability to provide technical research support has been leveraging funds to hire a research scientist in the School of Public Health, Dr. Sergei Chernyak. Dr. Chernyak has broad experience in laboratory and field methods for the collection and analysis of organic compounds in both biological and abiological samples. Dr. Chernyak plays a central role in two activities. First, he is directing the laboratory analysis of samples, primarily organic compounds, for several funded research projects. Other responsibilities include supervision of students and technicians, data analysis, quality assurance, and report and manuscript generation. Second, he is helping to increase the research and research training capacities of the Center in the NORA priority areas, such as developing exposure monitoring field methods, which are very complementary to the strengths of other ERC faculty.

In addition, the NORA funding was used to provide technical and biostatistical support of research in NORA priority areas being conducted by ERC faculty that includes direct involvement of Ph.D. and other students in core ERC programs. Support has included technical advice, research-related durable supplies, data entry and cleaning, and data management and analysis. Examples of studies which have benefited from this sort of support include a study of contact dermatitis among automotive assembly workers which constitutes the Ph.D. thesis topic of Mr. Aaron Sussell under the supervision of Dr. Robins, and a study of environmental and occupational risk factors for pancreatic cancer conducted by Dr. Garabrant.

## D.3. Coordination of interdisciplinary research

The coordination of interdisciplinary research across the many programs, disciplines, and schools represented within the Center requires substantial thought and planning. The NORA research support is used in a number of ways to assist with the coordination of interdisciplinary research. Firstly, Drs. Robins and Keyserling receive NORA research salary support to help them play their key coordinating roles as the Center's Director and Associate Director. Promotion of interdisciplinary research is a frequent topic of discussion at the bimonthly executive committee meetings at which all program directors are present. Attention to this issue has resulted in a large number of cross-disciplinary research projects in which students are involved. Some examples include contributions of Drs. Tom Armstrong in Occupational Safety Engineering, Al Franzblau in Occupational Epidemiology; service on the doctoral committees of SPH students by Occupational Safety Engineering faculty (Drs. Armstrong and Keyserling), and service by Dr. Franzblau in SPH on doctoral committees of students in Industrial and Operations Engineering.

Secondly, NORA funds are used to bring distinguished guest speakers to discuss interdisciplinary research topics of direct interest to ERC core faculty. The resulting interactive collaborations during seminars attended jointly by students from all of the Center programs and

subsequent formal meetings lead to substantially improve coordination of such projects among faculty. These visits are made especially cost-effective as possible by having the visiting faculty member both give presentations in seminar series widely attended by an interdisciplinary array of University of Michigan faculty and students, as well as participate in informal discussions with faculty in graduate students involved in NORA related research.

#### D.4. Training graduate students with NORA focus

Recruitment of students for research training. NORA research support is being used to attract graduate students with a NORA focus by paying for fees and staffing of booths at two key conferences at which the Center recruits students interested in research: the American Occupational Health Conference and the American Industrial Health Association Conference.

Direct support of doctoral students conducting research in NORA priority areas. Tuition and stipend support of doctoral students conducting research in NORA priority areas allows us to increase our total research training capacities. Funding during this past fiscal cycle was provided to one doctoral student in Occupational Epidemiology program: Ms. Jennifer D'Souza, who has received support to work with Dr. Franzblau on an externally funded study investigating the natural history of occupational musculoskeletal disorders, and one student in HSAT, Mr. Hien Le, who is working with Dr. Stuart Batterman to address statistical problems of missing exposure data in occupational and environmental epidemiologic studies.

Support of research projects in NORA priority areas in which students are participating. Examples of studies which have benefited from this sort of support include a study of contact dermatitis among automotive assembly workers which constitutes the Ph.D. thesis topic of Mr. Aaron Sussell under the supervision of Dr. Robins, and a study of environmental and occupational risk factors for pancreatic cancer conducted by Dr. Garabrant, in which doctoral candidate Ms. Gena Kucera participated.

Assistance with laboratory based courses teaching research principles. The NORA Research Support funding was used to provide general equipment, supplies, and laboratory assistance to enhance lab-based courses.

#### D.5. Training students who become occupational safety and health professionals to implement NORA findings in evidence-based practice.

The development and delivery of research related coursework, and continuing education, using distance learning modalities. NORA funds were used to help transform our long-standing and historically highly successful nonresidential executive Masters degree program known as On Job/On Campus (OJ/OC) from a fully face-to-face program with 22 monthly 4-day sessions in Ann Arbor to a mixed modality program using distance learning technologies to maintain the same quality while reducing the number of sessions in Ann Arbor to 11. This change has substantially improved our enrollment figures: 24 students in industrial hygiene, safety engineering, occupational health nursing, and occupational medicine will be commencing the newly designed program November, 2006.

#### D.6. Administration of Pilot Project Research Training Program

Support of pilot research training projects on NORA related topics. The NORA research support program provides assistance and administrative support to the PPRT through salary funding of both Dr. Keyserling who serves as Director of The University of Michigan Pilot Project Research Training Program, and Ms. Shelley Withem who serves as the Administrative Assistant. This enables us to increase the amount of funds that can be used to directly support pilot projects.

## F. Future Plans

During the next budget period we intend to use these NORA funds to:

- Provide technical support of research and research training through partial funding of research scientists, purchase of state-of-the-art research equipment, durable research supplies, and data entry, cleaning, management and analysis;
- Train graduate students in research principles through updated student recruitment activities, direct support of doctoral students conducting research on NORA priority areas, direct support of research projects which includes student participation, and assistance with laboratory-based courses teaching research principles;
- Continue widespread advertising of competitive NORA Fellowships offering full tuition and stipend support to help attract the strongest doctoral students
- Direct support of the restructured course EHS 600 that will involve students across all the ERC programs working together on interdisciplinary OHS research projects under supervision of ERC faculty and the employee health and evaluation and control of occupational and environmental hazards units in the University of Michigan Health Systems. Support will include direct funding of the research projects and some support of faculty time.
- Provide administrative and technical support of pilot research training projects on NORA related topics
- Train students who are or will become occupational safety and health professionals to implement NORA findings in evidence-based practice through the development and delivery of research related coursework and continuing education using distance learning modalities
  - Planned new directions within this category include:
    - Building on the IH program Director, Dr. Zellers, joint appointment and long-standing substantial interactions with faculty and students in the Department of Chemistry, a collaborative research training pilot program that targets the recruitment and training of chemistry doctoral students in interdisciplinary NORA-related research.
    - Building on the Center's grant from the state of Michigan to provide ergonomics training and service, together with the experience of IH program faculty member Dr. Meeker, providing such training and services for small businesses in Michigan regarding chemical hazards.
    - Building on Center Director's Dr. Robins long-standing relationship with the United Automobile Workers (UAW) Union Health and Safety Department to provide support and evaluation for their peer trainer program, having Center faculty provide technical training in occupational health and safety to these peer trainers.
    - Building on the expertise and experience of the Occupational Safety and Ergonomics Program Director, Dr. Keyserling, together with Dr. Robins' experience in joint labor-management OHS initiatives between the UAW and automotive companies, conducting an evaluation and intervention addressing the high risk of serious injury or death from acute trauma among automotive skilled trades workers.
    - Building on the experience with the education of mid-career professionals in our On Job on Campus (OJOC) curriculum, Dr. Robins' experience with

bringing Fogarty international scholars to the University of Michigan for intensive short-term study, and the experience of Dr. Hu, Occupational Epidemiology Center Director and Chair of the Department of Environmental Health Sciences, with a similar very successful program at Harvard University, establishment of a Visiting Scholars Program.

## Program Progress Report

### A. Industrial Hygiene

### B. Program Director: Edward T. Zellers, Ph. D. , Professor

### C. Program Description

*Faculty participation.* The IH Program has a long tradition of strong faculty leadership, productivity, and commitment to academic training, scholarly research, and service to the profession. Over this past year, the core IH Program faculty comprised Professor Zellers, Professor James Vincent, and Assistant Professor John Meeker. Documentation of their original research is found in the list of archival papers and published conference proceedings in Appendix B.

Prof. Zellers has been IH Program Director since 1999. His work in the development of chemical sensor arrays and associated micro-analytical systems is at the cutting edge of the field and seeks to bring the revolutionary advances occurring in new technologies to bear directly on IH problems related to personal exposure monitoring, indoor air quality assessments, breath analysis, ambient-air monitoring, biomarker analysis, etc. Over this past year he has supported and been primary mentor for 8 PhD students (5 in Chemistry and 3 in EHS). He taught lecture and laboratory courses on the evaluation of chemical hazards (EHS 652, EHS 653) and parts of a graduate-level courses in the Chemistry Department on chemical separations and on imaging and spectroscopy (CHEM 646 and 648). He teaches in, and is co-director of, the continuing education course entitled "Comprehensive Review of IH" offered twice annually. He is a member of the Editorial Boards for the journals *Sensors and Actuators B* and the *Journal of Occupational & Environmental Hygiene*.

Prof. Vincent continues his world-renowned work in aerosol studies, including the development and optimization of new samplers, and he has also continued his contributions in the policy arena focusing on obtaining consensus on reconciling standards among multiple countries throughout the world. He teaches courses on environmental and occupational health sciences (EHS 550), ventilation for contaminant control (657) (in both residential and OJOC modes) and a course on occupational health practices (EHS 757) (residential course) and assists in the administration of the IH Program in numerous substantive ways. Prof. Vincent had an R01 research grant under the NIOSH NORA program during this reporting period.

Prof. Meeker was hired in September, 2005 and has bolstered the IH faculty in the area of exposure assessment. He already has an active extramurally funded research program focused on reproductive health effects arising from exposures to tobacco smoke, pesticides and other chemical agents, and increased his teaching and advising contributions by taking over our course Physical Hazards (EHS 658) and developing a new course on Advanced Exposure Assessment (EHS 657), offered for the first time in Winter, 2007. Prof. Meeker has co-authored 20 peer-reviewed publications and presented a similar number of presentations at conferences. He has continued his involvement in research-to-practice activities aimed at increasing the effectiveness and use of engineering exposure controls in the construction industry. All of the IH faculty carry out research that addresses several NORA research priorities.

Numerous additional faculty contribute to the IH Program by teaching courses, mentoring students, and providing input to the nature and quality of the curriculum. The most prominent of these are T. Robins (ERC Director, EHS 507), A. Franzblau (EHS 501), D. Garabrant (EHS 508, Risk Science Center Director, former OE Program Director), M. Keyserling (IOE 539, OSE Program Director, ERC Deputy Director), S. Batterman (EHS 574, HSAT Program Director), O. Hong (NURS 606, OHN Program Director), J. Miklos (EHS 581), and B. Joseph (EHS 656).

*Mission, Goals, Objectives:* The mission of the IH Program is to provide broad-based academic

training in occupational health, ensure that graduates are qualified to pursue careers and assume leadership roles in the practice of industrial hygiene, and mentor those pursuing doctoral level training in research at the cutting edge of the IH field to prepare them for careers in academia or research and development. As part of this mission, Program faculty recruit highly qualified students to the Program, engage in independent research projects to advance the state of knowledge in IH, and perform service activities regionally, nationally, and internationally. The overarching goals developed to support the mission of the IH MPH Program are:

1. Enroll and graduate top-quality students in sufficient numbers to help assure an outstanding graduate-level educational experience, continued strength and recognition for the IH program, and a significant contribution to the pool of qualified IH professionals to serve regional and national needs.
2. Establish and maintain an outstanding faculty committed to providing exceptional educational experiences for the students, innovative IH scientific research, and professional service to the broader IH community.
3. Provide financial aid to IH students to enable them to matriculate and graduate.
4. Maintain a comprehensive curriculum to prepare students for professional practice and certification.
5. Develop and maintain excellent facilities for training students and conducting cutting-edge IH research.
6. Secure external funding for supporting students and faculty research in areas of critical need.
7. Conduct effective and successful continuing educational activities to meet needs of IH practitioners and provide additional revenue for the IH program.
8. Inspire students to foster the highest standards of integrity, ethical conduct, and professionalism in their careers.
9. Engage and motivate IH program alumni to support students (e.g., via advising, internships, and full time employment) and the IH program (e.g., via advising, scholarships, and monetary donations)

*Responsible Conduct of Science.* The University of Michigan is firmly committed to the highest standards of ethical conduct in education and research. All IH students are required to complete a series of awareness training modules through the University Program for Education and Evaluation in Responsible Research and Scholarship ([www.research.umich.edu/training/peerrs.html](http://www.research.umich.edu/training/peerrs.html)), which address (1) foundations for responsible research conduct; (2) institutional review board (IRB) procedures related to human subjects research; (3) conflicts of interest; (4) animal research; and (4) the Health Insurance Portability and Accountability Act of 1996 (HIPAA) related to privacy of personal data. This training is done on-line and includes examinations and certificates that are awarded to document successful completion. Lectures and reading materials on ethics included in classes such as EHS 550 and EHS 600, and a code of conduct outlining expected elements of academic integrity is circulated and discussed in every course in the IH curriculum.

*Curricula.* We pride ourselves on the comprehensiveness of our Master's IH curricula, and feedback received from our constituencies consistently indicates that we should continue to impart solid training in classical IH skills, knowledge, and concepts. Students pursuing careers as practitioners elect the 60-credit-hour MPH degree option, with core courses in biostatistics, epidemiology, exposure assessment, risk assessment, air sampling and analytical methods (lecture and lab), management, toxicology, occupational diseases, ventilation, safety, radiation, occupational law and policy, ergonomics, noise and other physical hazards, in addition to electives in related areas. The 48-credit-hour MS degree program focuses more on research/technical skills and serves as a doctoral-preparative training program. The MS degree option requires a formal thesis. MPH and MS degree requirements are completed in four academic terms. The residential MPH includes a formal summer

internship, which serves for most students as a capstone project that requires integration of skills learned in coursework and documentation of mastery in the form of a report and presentation. For our On Job/On Campus (OJOC) students, the integrated work project (IWP) serves as the capstone research project. All MPH students are required to take two SPH “breadth” courses (one in health behavior and health education and one in health management and policy). Appendix A provides required courses and sample curricula for the IH MPH degree (residential and OJ/OC), IH MS degree, and IH PhD degree.

#### **D. Program Activities and Accomplishments**

*Meeting goals and objectives:* We were successful in recruiting 16 new students in the Fall of 2006: 6 new residential MS/MPH IH students, 8 new OJOC MPH IH students, and 1 new PhD student. The average undergraduate GPA was 3.2 and average GRE scores (V and Q) were  $\geq 50^{\text{th}}$  percentile. Seven of these students were supported by the NIOSH ERC. Total enrollment in the IH Program as of Fall, 2006 was 29 students: 21 MPH (includes HSAT students), 2 MS, and 6 PhD students. Of these, 11 (38%) were women, 5 (17%) were of African American or Hispanic, and 9 (56%) were Michigan residents. Thus, we are meeting goals for enrollment in terms of numbers of students, quality, diversity, and regional need. A total of 9 students graduated from the program during the reporting period, 8 of which took positions in occupational and environmental health in organizations located around the world. We placed all of our continuing students in IH-relevant internships during the summer of 2006. The curriculum remained strong as indicated by high evaluation scores ( $> 4$  out of 5 in most courses), high overall satisfaction by students as reflected in exit survey results, and successful placement of graduates in relevant jobs. All core IH faculty have active, extramurally-funded research programs (totaling over \$1.2M in direct costs), they collectively generated 27 scholarly publications, and have served the IH community in a number of substantive ways.

*Trainee honors, awards, scholarships.* Our students have received a number of awards over the past year, including: AIHF George and Florence Clayton Endowed Scholarship Award, Gustavo Serrano; AIHF Ralph Smith Endowed Scholarship Award, Pamela Dopart; AIHF Michigan IH Society Scholarship, Jennifer Hsu

MIHS Award, Matthew Johnson; 2006 EHS MPH Poster Competition, 1<sup>st</sup> Place – Joseph Moralez, Honorable Mention – Hollie Quisenberry and Ryann Fischer; Warren Cook Award, Aaron Sussell.

*Faculty honors and awards.* Professor Zellers delivered invited talks at the PCIH (September, 2006), Pittcon (March, 2007), and Transducers '07 (June, 2007) concerning his research on microanalytical systems for airborne contaminants. His joint appointment as Professor of Chemistry was renewed for another 5 years. Professor Meeker became a CIH in October, 2007.

*New faculty positions.* There were four faculty hired into the EHS Department in 2005, including a new Chair, all of whom are now having positive impacts on the IH Program. One additional faculty member was hired in Fall, 2006: Marie O'Neill (Asst. Prof., 50% appt., started in September, 2006) who brings expertise in environmental exposure assessment and epidemiology. We also successfully recruited and hired Prof. Nil Basu (Asst. Prof., started in September 2007) who brings expertise in exposure biomarkers. Each of these faculty has or will contribute to the IH Program through teaching, mentorship, and/or by expanding the scope of research accessible to students.

*New courses.* The OJ/OC Program underwent a major reconfiguration to incorporate distance learning components and to reduce the number of visits students must make to campus (which, in turn, reduces cost). This required a 1-year hiatus in the program from 2005-06. Enrollment is now 16, with 8 of these being IH students. Beginning with the 2006 cohort, a formal lab course was incorporated into the OJ/OC curriculum (EHS-653, *Environmental Sampling and Analysis Lab*, 1 credit-hour).

In response to NIOSH suggestions for integrating the OHN faculty more completely into the ERC curricula, we launched a new course, NURS 606 (Management for Occupational & Environmental Health and Safety Professionals) that was taken by IH students and students from the other ERC Programs. Dr. Meeker developed and taught a new course, EHS 657, Advanced Exposure Assessment, which was rated highly. Currently an elective, we are working on revising the IH core curriculum to make it a required course. Dr. Joliet, hired in 2005, is currently teaching a re-configured

version of EHS 600, Professional Perspectives in Environmental Health, which is now a projects-oriented course that teams students from the different disciplines across the ERC together with practitioners to work on real-world problems faced in hospitals (required by all IH MPH students). He will also be starting a new course entitled Life Cycle Assessment: Human Health and Environmental Impacts, which will be an elective for IH students.

### **E. Program Products**

The core IH Program faculty produced 27 peer-reviewed papers, books, book chapters, patent disclosures, and conference proceedings papers published or submitted over the past year, of which 8 involved student co-authors (Appendix B). Approximately 15 presentations were delivered at professional conferences and other formal venues by IH faculty and their students this past year. Perhaps most significant among the publications of our faculty is Professor Vincent's latest massive contribution to our field; the textbook entitled *Aerosol Sampling – Science, Standards, Instrumentation, and Applications*, which provides a comprehensive review of the broad field of aerosol sampling.

As stated above, Prof. Zellers co-directs and teaches in the continuing education course entitled "Comprehensive Review of Industrial Hygiene", which was offered twice last year and has been extremely successful in attracting enrollment. Other ERC faculty that participate in this course include Profs. Franzblau, Robins, Dvonch, Miklos, and Batterman. The remaining instructors in the course are drawn from regional experts that are members of the local section of the AIHA. All the IH faculty participate in the annual Warren Cook Memorial IH Discussional each October.

Prof. Meeker is leading our efforts to accelerate the translation of our research into practical forms that directly benefit workers and other OH professionals. Research-to-practice activities in which he is engaged (since 2005) involve exposure assessment and engineering controls in the construction industry in collaboration with the Center to Protect Workers Rights (CPWR). As part of this collaboration, Prof. Meeker has given research presentations and played a lead role in organizing information from NIOSH/CPWR Engineering Controls Workgroup Meetings in 2005 and 2006. These 2-day meetings bring together representatives from government, academia, industry and labor to discuss progress and future goals for reducing occupational exposures in the construction industry.

IH faculty research funding has been quite healthy this year, with extramural grants from the National Science Foundation, NIH, NIOSH (1 R-01 grant and 1 NIOSH-Pilot Project grant), the Department of Homeland Security, Intel Corporation, NASA, and the Flight Attendants Medical Research Institute (FAMRI). All of these projects involved support of, and participation by, students. The program assembled and submitted a Self Study Report, and went through a site visit as part of its effort to receive re-accreditation by the American Board of Engineering and Technology (ABET). The site visit was held in October, 2006 and went extremely well. Re-accreditation was awarded in July, 2007.

### **F. Future Plans**

*Planned initiatives.* Several activities and initiatives are planned for this next year. We will be implementing several changes to the way in which the IH curriculum is assessed and managed. For example, we are incorporating a new course evaluation mechanism that addresses the extent to which intended goals and competencies have been met. We will also be bolstering the way we solicit and use feedback on the program from our constituencies in order to improve the program. We have already been shifting some content of the IH laboratory course (EHS 653) to encompass several issues relevant to ambient environmental health, and will now be having IH students take this class alongside students majoring in Environmental Health. Another initiative that expands our interdisciplinary training is to morph our current capstone course, EHS 600, in a way that teams students from multiple disciplines on a project that draws upon their disciplinary perspectives to characterize or solve a practical problem.

## Occupational Health Nursing Progress Report – July 1, 2006 – June 30, 2007

### A. Program Title – Occupational Health Nursing (OHN)

#### B. Program Director – Dr. OiSaeng Hong, Associate Professor

During the reporting year, Dr. Hong (30% effort) served as the Program Director. Dr. Hong resigned from the School of Nursing, effective July 1, 2007, to accept a position at the University of California at San Francisco in their OHN program. Upon Dr. Hong's departure Dr. Violet Barkauskas (30% effort) assumed Interim Directorship. She is responsible for the overall coordination of OHN MS and doctoral training until a new director is hired. During the interim time period, Dr. Deborah Sampson (20%) serves as the Deputy Interim Director for the Program. Dr. Lusk, former director, will continue to be available to provide support to Drs. Barkauskas and Sampson during this leadership transition period. Dr. Barkauskas has been a faculty in the OHN program since 1997 and Dr. Sampson has a strong practice background as a nurse practitioner (NP) in OH services.

The recruitment of an OHN Program Director was initiated in the summer of 2007. Dr. Barkauskas was appointed Chairperson of the Search Committee and members are Drs. Sampson and Lusk from the SON and Dr. Franzblau from the Occupational Epidemiology Program of the UM NIOSH ERC. To date, each NIOSH-funded OHN Program has been personally contacted by phone by Dr. Lusk and by letter by Dr. Barkauskas to solicit nominations and applications for the position.

#### C. Program Description (Include description of: goals and objectives; responsible conduct of science training; faculty participation; curricula.)

The UMSON currently offers the MS degree with specialization as an OHN clinical nurse specialist (OHN-CNS). The SON also offers PhD research training with specialization in OHN. The SON proposes to offer an OHN-Nurse Practitioner (OHN-NP) option for Fall 2008.

**OHN-CNS Option:** The goal of the OHN-CNS Program is to prepare advanced level OHN specialists and leaders with expertise in professional practice, administration and management, and program development and evaluation. Graduates are prepared to identify health hazards in the work environment and propose appropriate control strategies; design, implement and evaluate health programs for the working population; monitor and consult on legislative and regulatory changes pertinent to OHS; identify research questions from OHN practice; and develop the policies and procedures, professional and referral networks, and data-based systems central to OH service activities.

This program is taught in an on-job-on-campus (OJ/OC) structure which is offered in conjunction with other OH OJ/OC graduate programs in public health and engineering. The OJ/OC format offers a flexible option for nurses interested in pursuing advanced degrees in OHN who may not be able to participate in traditional programs while holding down full-time jobs as well as those who would not be able to relocate or to leave their current positions to attend school. One benefit of the OJ/OC format is ample opportunity for interdisciplinary learning. OHN students take a total of 22 credits in eight required cognate courses and an additional two credits in an interdisciplinary course taught by nursing faculty with students from other ERC academic programs. In addition, the format provides a laboratory for collaboration, and interdisciplinary professional networks become very strong during the OJ/OC program and continue long beyond the cohorts' visits to campus.

To increase program flexibility, the OJOC format was restructured to include approximately 50% web-based distance learning to aid recruitment of well-qualified students to the OHN program. The revised OJOC format, a unique combination of on-campus and distance learning, was implemented in Fall 2006. In the new format, students are on campus Thursday through Sunday approximately every other month, reducing the on campus time by about 50%.

A total of 47 credit hours (10 for nursing core courses required of all nursing master's students; 17 for nursing specialty community/OHN courses; 13 for interdisciplinary OSH courses, and 7 for public health core courses) are required to meet degree requirements. The curriculum components are displayed below. (See Appendix A-1 for specific OHN-CNS master's degree course requirements.)

Students' annual course evaluations and alumni surveys repeatedly indicated the importance of integration of occupational and environmental health and safety (OEHS) content into OHN courses, and their desires to have more content on the fundamentals of business and management specific to the field of OEHS. Professionals in OEHS, including OHNs, are often required to perform a variety of management and administration functions, including supervising staff, budgeting, financial management, business planning, allocating resources, and complying with laws and regulations. Thus a new multi-disciplinary course, N606, Management for Occupational & Environmental Health, and Safety (OEHS) Professionals was developed and offered for the first time in Winter Semester, 2007. Knowledge and skills obtained through this new course will bring value to OEHS professionals and their employers and organizations.

During this year, the primary SON faculty participating in MS courses for OHN students were Drs. Barkauskas, Hong, and Strasser.

**PhD Program:** The goal of the Ph.D. program is to prepare nurse scientists and leaders who will contribute to knowledge development in nursing, and to assume leadership positions in the profession. The emphasis of the OHN doctoral program is on clinically-relevant research. The OHN doctoral trainees can participate in ongoing faculty research through negotiated experiences. All doctoral students at the UMSON are required to complete at least one research experience with a faculty member's project. The curriculum of the doctoral program builds on baccalaureate and/or master's education in nursing. Course requirements, listed in Appendix A-2, are applicable to post-baccalaureate students. For a student who is a graduate of a master's degree program in nursing, the program planning committee evaluates the student's previous graduate work for equivalence in content and level to the 500 and 600 level courses in the program. The 800 level courses (doctoral level) must be completed by all students.

The program plan for doctoral students is conceived to be interdisciplinary in approach. Several aspects of the program provide for interdisciplinary advisement. Students are required to take cognate courses and cognate faculty membership is required on the preliminary exam and dissertation committees. All PhD students are required to complete responsible conduct of research training and certification.

Program requirements are distributed across three areas of knowledge: 1) **nursing and nursing theory**, 2) **research**, and 3) **cognates**. The **nursing and nursing theory** core is the component of the curriculum that provides the knowledge deemed essential to advanced study. It is the knowledge on which specialization builds and provides the students with breadth of understanding as well as depth in selective areas. **Advanced nursing courses** are designed to enable students to analyze extant relevant research, study the theoretical propositions that have evolved, and identify gaps in knowledge. Both theoretical and methodological concerns are addressed. The **research** component of the curriculum includes coursework in research methods and statistical and qualitative approaches to data analysis, and research experiences selected to enable students to meet the research-related program objectives. In addition to the required coursework and research experiences, there is an emphasis on research throughout all of the courses and activities in the program. **Cognates** are courses taken in other schools, departments, or institutes within the University. The program planning committee and the student select cognates based on their relevance to the student's goals and research plans.

The **preliminary examination** focuses on an identified OHN problem that requires integration and synthesis of knowledge from nursing and related cognate theories and research. It typically consists of the preparation of two to three papers and an oral defense. The examination committee is comprised of at least two SON faculty members and at least one cognate faculty member. Upon successful completion of the preliminary examination, the student is admitted to candidacy and then completes a dissertation focusing on an OHN topic. To ensure that OHN students select a research focus relevant to OH, the OHN Program Director serves as the students' academic advisor and chair of her/his program planning committees and as chair or member on each student's preliminary examination and dissertation committees to ensure relevance of their topics to OHN. Students are encouraged to have other ERC faculty as cognate members on these committees.

Currently three students are enrolled in the doctoral program and they are focusing their work on musculoskeletal injury in nurses (Geun), occupational health and safety in the nanotechnology industry (Huang), and physical activity and health promotion in workers (Lin).

#### **D. Program Activities and Accomplishments**

**Trainees:** In this academic year, seven (three full-time and four part-time MS and three PhD [one US resident and two international]) students were enrolled. Two of the part-time MS students completed degree requirements within the academic year.

#### **Faculty: [OHN related achievements are listed only]**

##### Dr. OiSaeng Hong

- Served on the preliminary examination and dissertation committees for an OHN doctoral student at the University of Illinois at Chicago
- Provided consultation in curriculum development for OHN graduate program and research training and conducted collaborative research in other countries (Brazil, Korea)
- Served as board member and mentor for postdoctoral research training for the Global Korean Nursing Foundation.
- Participated in conducting the international collaborative research on global changes in nursing employment and occupational health, funded by the University of Occupational and Environmental Health, Japan
- Served as representative of the AAOHN on the National Task Force to develop professional competency levels for doctorally prepared clinical nurse specialists.
- Was Guest Editor for the American Association of Occupational Health Nurses (AAOHN) Journal, editorial board for Korean Nursing Science Journal (English issues),
- Was Principal Investigator or Co-Investigator for the following research projects:
  - The Prevalence of Smoking, Alcohol, and Depression Among Construction Workers
  - Risk Factors For Hearing Loss in Older Mexican Americans
  - Web-Based Survey of Hearing Protection Behavior In Workers Of Six Power Plants in Korea
  - NIHL-Expert (NIHL-e) System Intervention: Developmental Stage I
  - Job Delineation Research with Occupational Health Nurses in Brazil
  - Occupational Exposure, Knowledge, and Protective Behaviors Among Korean Dry-Cleaners

##### Dr. Violet H. Barkauskas

Provides evaluation direction to two initiatives funded by the W. K. Kellogg Foundation and the Department of Health and Human Services.

##### Dr Sonia Duffy

Principal or C-Investigator on six funded grants focused on management of diabetic patients, smoking cessation, and head and neck cancer.

Dr. Sally Lusk

Completed her term as President, Midwest Nursing Research Society.

Dr. Patricia Strasser

Continues to serve on the Editorial Review Panel for the AAOHN Journal.

**Students**

A recent graduate (Clark) won the award from the ABOHN for the highest score in the case manager certification examination in 2007.

**Overall Achievements**

- Orientation of Dr. Sonia Duffy to the teaching program – she will be the lead faculty for the community assessment and the program planning, implementation and evaluation courses.
- Adaptation of the original OJ/OC structure to incorporate a substantial distance learning component.
- The SON conducted over 42 recruitment events targeting prospective students, including OHN applicants, for a combined attendance of over 4,000 prospective nurses.
- Enrollment of five ethnically diverse students (1 African American, 4 Asian Americans [1 Asian Indian, 1 Chinese, 1 Korean, and 1 Taiwanese]).
- Initiation of planning for an OHN Concentration in the Adult Nurse Practitioner Program.
- Dr. Anne Thomas completed a major continuing education program on health assessment for OHNs. This activity has proven to have a substantial MS student recruitment benefit.

**E. Program Products.** Publications of faculty and former students are listed in Appendix B.

**F. Future Plans**

- Recruitment of a permanent director of the OHN program
- Continuance of student recruitment efforts. A new cohort for the OH OJ/OC Program will be admitted for September, 2007.
- Implementation of the OHN Concentration in the Adult Nurse Practitioner Program

**OHN-NP Option (in Planning):** An OHN-NP MS option is a proposed addition in the next grant period. At the recent (April, 2007) ERC Advisory Board meeting employers expressed the opinion that the current OHN staffing need was for NPs, rather than population-focused CNSs and recommended that a NP option be added to the OHN offerings. In fact, OHN faculty have been discussing an OHN-NP option for some time as demand for such graduates has been increasing in the local community. During the past two years, one of the OHN program graduates has completed the ANP program as a post-master's option and three more (two current students and one graduate) are considering the completion of an NP post-master's program as well. An OHN-NP program could be developed as a concentration within the existing ANP Track without the development of any new courses. The ANP program faculty reported that ANP students were already receiving some clinical experiences in OH settings.

The proposed OHN-NP program will provide graduates with advanced clinical skills to diagnose and treat work related injuries and illnesses in collaboration with other core OHS disciplines. The proposed OHN-NP curriculum (Appendix A-3) will require a total of 59 credits. The OHN-NP curriculum will use the ANP Track requirements as the basic curriculum with the addition of OH cognate courses. No courses in the ANP curriculum can be eliminated because of national ANP certification requirements. No specific course, credit hour, or practicum hour standards currently exist for OHN master's degree programs, so the specific content and practicum hour standards issued by other nursing groups for NP education and certification will serve as the primary guidelines for the new OHN-NP curriculum. The program will also be guided by the *Competencies in Occupational and Environmental Health Nursing* published by the

AAOHN (2003). The priority OH courses include: Epidemiology, Introduction to Occupational and Environmental Health, Occupational Diseases, Occupational Safety, Occupational Ergonomics, and Current and Emerging Issues in Occupational Health Practice. Additional courses in OH that might be of interest are not required owing to concerns about excessively heavy credit loads for students along with the related expenses. Thus the proposed curriculum contains the minimum content considered priority and essential. Students can elect additional courses, if workloads allow, from the rich array of OH courses available in the University. For clinical experiences, OHN students will be placed in OH programs and will be supervised by Dr. Sampson, an experienced OHN NP. The SON has several formal contracts with OH clinical sites in which students can receive precepted clinical experiences in primary care and, during the 2007-2008 academic year, additional clinical sites will be recruited for the OHN-NP option, which is scheduled to enroll students for the 2008-2009 academic year.

## Reference

American Association of Occupational Health Nurses. (2003). Competencies in occupational and environmental health nursing. *American Association of Occupational Health Nurses Journal*, 51(7), 290-302.

## Occupational Safety Engineering and Ergonomics Progress Report:

### A. Program Title

*The University of Michigan Center for Occupational Health and Safety Engineering,  
Program in Occupational Safety Engineering and Ergonomics*

### B. Program Director

W. Monroe Keyserling, Ph.D.  
Professor of Industrial and Operations Engineering

### C. Program Description

#### C.1 Brief History and Goals

Graduate training in Occupational Safety Engineering and Ergonomics (OSE) has been offered by The University of Michigan's Department of Industrial and Operations Engineering (IOE) since 1971. This program was incorporated into the Michigan ERC in 1982 and renewed during site visits in 1984, 1989, 1994, 1999 and 2004.

Our goal is to be an internationally-recognized center of excellence for research and graduate education in the design, analysis, implementation and improvement of facilities, equipment and processes to assure the safety and well-being of human resources in the workplace. Our educational programs include:

1. Professional training (Masters degrees). Intended for students who wish to pursue careers as full-time safety and ergonomics professionals. Students complete a curriculum that covers technical and managerial topics, learn basic research methods and complete an independent research project. To view a sample curriculum and list of elective courses, please see Appendix A.
2. Research training (Ph.D. degrees). Intended for students who wish to pursue careers in academic, government and industrial research settings. Following extensive coursework, students conduct research in either a laboratory or field setting.
3. Continuing education. Short courses are provided for occupational health professionals, managers, engineers, and labor representatives who desire specialized training in safety and ergonomics.
4. Cognate courses for students in other disciplines. Courses in safety and ergonomics are taken for elective credit by undergraduate and graduate students from a variety of non-core academic programs (e.g., mechanical engineering, construction engineering, manufacturing engineering, naval architecture and business administration).

Since 1971, we have graduated 251 Masters and 79 Ph.D. students who completed the OSE degree option. For the reporting year (July 2006-June 2007), we had 5 Masters and 7 Ph.D. graduates.

#### C.2 Responsible Conduct of Science Training

The University of Michigan is committed to the responsible conduct of faculty, staff, and students in all aspects of research. As part of this commitment, the university has established a web-based system for training and certifying faculty, staff, and students on responsible research practices. Faculty, staff and students who serve as investigators or research assistants must complete modules on: 1) Foundations of Responsible Research Conduct (e.g., ethics and legal requirements related to publication/authorship, intellectual property, conflict of interest, plagiarism, misconduct reporting, etc.), and 2) Human Research (e.g., why human subjects research is regulated, regulatory and ethical responsibilities of the PI, IRB and

University, etc.). Each module includes a test which must be successfully passed in order to achieve certification. The PEERRS website can be accessed at the following URL:

<http://www.research.umich.edu/training/peerrs.html>

In addition to the formal certification process, students work with faculty mentors to develop research protocols, write informed consent documents, prepare IRB applications and collect data on human subjects. Most Masters-level trainees and all Doctoral-level trainees play a significant role in submitting at least one complete IRB application in conjunction with the research projects required for their degree.

### C.3 Program Faculty

The OSE program at The University of Michigan is fortunate to have a large, stable, and highly-productive faculty. Nineteen faculty and staff members (see Table OSE--1) teach OSE courses and advise student research. The seven tenured and one emeritus IOE faculty listed in Table OSE--1 have special roles (e.g., curriculum planning and evaluation, student counseling, student recruitment, administration of doctoral exams, etc.) in addition to teaching and research. Eleven additional members of the faculty and staff are involved in teaching OSE classes, advising student research and/or providing laboratory support. Finally, faculty from other university units (not listed in the table) contribute to the program by teaching courses in industrial hygiene, epidemiology, construction safety, systems reliability, management, and program administration.

Table OSE--1. Contributions of OSE Faculty and Staff

<b>Name</b>	<b>Specialization/Interests</b>	<b>Rank/Title</b>
<b>Tenured Faculty</b>		
Dr. W.M. Keyserling, (OSE Program Director)	Safety Engineering, Ergonomics, Trucking/Warehousing	Professor
Dr. T.J. Armstrong	Biomechanics (Upper Ext.), Office Ergonomics, Rehab.	Professor
Dr. D.B. Chaffin	Biomechanics (Low Back), Manual Mat. Handling	Professor Emeritus
Dr. G.D. Herrin	Applied Statistics, Experimental Design	Professor
Dr. B. Kantowitz	Cognitive Ergonomics, Transportation Safety	Professor
Dr. Y. Liu	Cognitive Ergonomics, Human/Computer Interaction	Associate Professor
Dr. B.J. Martin	Work Physiology, Occupational Vibration	Associate Professor
Dr. N. Sarter	Cognitive Ergonomics/Transportation Safety	Associate Professor
<b>Supporting Faculty and Staff</b>		
Dr. P. Adams	Safety Engineering, Safety Management	Adjunct Assistant Prof.
Dr. P. Frantz	Warning Systems, Product Safety, Safety Management	Adjunct Assistant Prof.
Dr. A. Franzblau	Musculoskeletal Disorders, Epidemiology	Research Scientist
Dr. P. Green	Human Factors (Controls/Displays)	Research Professor
Dr. M. Reed	Anthropometry, Biomechanics, Human Motion	Assoc. Research Prof.
Dr. T. Rhoades	Product Safety, Safety Management, Transportation Safety	Adjunct Assistant Prof.
Dr. Omer Tsimoni	Transportation Safety, Simulation	Asst. Research Scientist
Dr. S. Ulin	Participatory Ergonomics/Plant-based Programs	Sr. Research Associate
Dr. R. Werner	Musculoskeletal Disorders, Epidemiology	Research Scientist
Mr. C. Woolley	Research Instrumentation, Ergonomic Software	Research Engineer
Mr. E. Claxton	Technical Support, Instrumentation Shop and Labs	Engineering Technician

There have been several changes to faculty and staff since our last report.

- Professor Emeritus Don Chaffin retired from faculty service at the end of 2006. However, he remains very active in ongoing research projects and continues to chair several dissertation committees.

- Professor Gary Herrin completed his service as Dean of Undergraduate Education in the College of Engineering, and has resumed a full-time academic appointment in IOE. This will allow him to return to a normal load of teaching and supervising student research.
- Dr. Omer Tsimoni, an Assistant Research Scientist at the U of M Transportation Research Institute, has joined the IOE faculty as an Assistant Professor. He teaches our course on Simulation (IOE 474) and serves on several dissertation committees in the area of cognitive ergonomics.

#### C.4 Curriculum

During the 2004 site visit, a new Masters curriculum was approved. The core of this curriculum is 20 credits of required coursework and seminars in core areas of safety engineering, OHS management, industrial hygiene, epidemiology, statistical methods; including 14 credits taken with students from other disciplines in our ERC. A new core course, EHS 600, was added for the 2007-08 academic year. This new course, "Professional Perspectives in Environmental Health" brings together OSE students from all ERC cores to work on interdisciplinary team projects themed around occupational and environmental health problems. In addition to their formal coursework, all NIOSH trainees must complete a 3-4 credit research project. Building on these core requirements, our Masters students are free to choose electives from almost 50 graduate courses in order to specialize in one or more of the following areas: physical ergonomics, cognitive ergonomics, safety engineering, or OHS management. The Masters degree can usually be completed within a calendar year. Please refer to OSE--Appendix A for additional information.

The Ph.D. degree typically requires 4-5 years to complete. Students build on the Masters degree and develop research skills by taking additional upper-level graduate courses in statistics/experimental design, epidemiology, safety, biomechanics, physiology, psychology, and laboratory/field research methods. To assure an early research experience, each Ph.D. student must identify a research advisor and write a brief research proposal during the fall term of the first year. In the winter term, the student works closely with his/her advisor to complete a small project and write a final report. During the second year, the student continues working with the advisor, performing additional research and writing a formal dissertation proposal. Doctoral examinations are given at the end of the first year (the Qualifying Exam) and early in the third year (the Preliminary Exam) to assess progress. The Qualifying Exam focuses on performance in coursework and the first-year research project. The Preliminary is a comprehensive evaluation of the research proposal and the student's preparation to perform the proposed work. After passing the Preliminary Exam, the Dissertation Committee is responsible for advising the student and assuring the quality of the doctoral research. Advanced Ph.D. students are also expected to publish and present their findings at scientific meetings.

### D. Program Activities and Accomplishments

The 2006-07 reporting year was highly successful, with many accomplishments and achievements. We enrolled a total of 30 full-time (21 Ph.D., 9 M.S.). Looking at program outputs, we had seven Ph.D. and five M.S. students graduate during the reporting year. Additional details, including placement information, were provided to NIOSH in the supplemental tables submitted in August 2007 with our competing renewal application.

Major accomplishments of students and faculty, and major program developments are highlighted below.

#### D.1 Trainee Honors, Awards, and Scholarships

Our students won several prestigious awards during the reporting year:

- Four of our Ph.D. students (Michael Bauerly, Marc Berman, Thomas Ferris, and Suzanne Hoffman) were honored as NSF Graduate Fellows.

- Mr. David Wagner won a College of Engineering Outstanding Graduate Mentor Award for excellence in supervision of undergraduate research.

## D.2 Faculty Honors, Awards, and Appointments

Significant faculty accomplishments include:

- Prof. Don Chaffin received the 2007 Arnold M. Small President's Distinguished Service Award from the Human Factors and Ergonomics Society.
- Prof. Yili Liu received the 2006-07 Jon R. and Beverly S. Holt Award for Excellence in Teaching.
- Prof. Thomas Armstrong served on the ACGIH Physical Agents Committee.
- Profs. Don Chaffin, Monroe Keyserling, and Nadine Sarter served on National Research Council Committees.
- Adjunct Prof. Paul Adams served as Vice President of the Board of Certified Safety Professionals.

## D.3 Trainee Dissertations and Theses

Dissertation titles and advisors for our Ph.D. graduates are listed in OSE--Appendix B. In addition, our M.S. and Ph.D. students were sole authors or co-authors on five technical reports. (Note: Our Masters program does not have a formal thesis requirement; however, all NIOSH trainees must complete a directed research project that culminates in a technical report.)

## D.4 New Courses

The following new courses were developed during the reporting year:

- NUR 606: OHS Program Management was added to the curriculum as an interdisciplinary course with other ERC Cores.
- IOE 634 (Laboratory in Biomechanics) and IOE 636 (Human Performance Laboratory) were restructured into a single course (IOE 691).
- Prof. Paul Green developed a new course on Automotive Human Factors (IOE 437).

## D.5 Trainee Recruitment and Diversity

For the 2006-07 reporting year, OSE enrollment was 30 students (9 Masters and 21 Ph.D.) Among this group, 14 students (47 percent) were females, and 20 students (67%) were U.S. citizens. Among the 20 U.S. citizens, seven students (35%) were underrepresented minorities. Among our 12 graduates, five were female (42%) and nine (75%) were U.S. citizens. Among the nine citizens, three students (33%) were underrepresented minorities. For the Fall 2007 term (next reporting year), OSE enrollment stands at 25 students (6 Masters and 19 Ph.D.) with 12 females (48%) and 3 underrepresented minorities (16%). As part of our recruiting efforts to increase enrollment of underrepresented students, we participate in the College of Engineering's PREVIEW and IMPACT programs. The PREVIEW program sponsors campus visits for potential M.S. and Ph.D. students during the Fall term (including GEM, LSAMP, McNair, and Meyerhoff scholars), allowing students to visit laboratories and meet with current faculty and students. (Note: Travel expenses are covered by the University). The IMPACT program focuses on the recruitment of Ph.D. students. A campus visit is provided to tour facilities, meet with potential dissertation advisors, and discuss possible dissertation topics. Finally, the College of Engineering sponsors faculty visits to HBCUs and universities in Puerto Rico to meet with potential students and discuss opportunities for graduate school.

## **E. Program Products**

### **E.1 Publications**

2006-07 was a highly productive year for publications. Our faculty and students produced a total of 90 publications and presentations with students serving as sole author or co-author on 48 publications. A complete list with bibliography citations appears in Appendix OSE-B.

### **E.2 Research-to-Practice (R2P) Activities**

We consider technology transfer to be an important part of our ERC mission. A few of our R2P activities for the reporting year are highlighted below:

- The U of M Center for Ergonomics, in cooperation with the State of Michigan, provides ergonomics consulting and training services to small and medium-sized companies. In a typical year, we are able to respond to approximately 12-15 requests for in-plant assistance. During the 2006-07 reporting year, we continued a new initiative that involves our Ph.D. students in this program. We believe that this type of service delivery activity greatly enriches the education of our students while providing additional services to clients.
- Professors Barry Kantowitz and Paul Green, in conjunction with The University of Michigan Transportation Institute are involved with multiple studies to improve the safety performance of both commercial and passenger vehicles. Because highway crashes continue to be the leading cause of occupational fatalities in the United States (BLS, 2007), this research has important benefits to the safety of the American workforce.
- Professors Don Chaffin and Bernard Martin are working with a consortium of private sector and federal sponsors (including the Dept. of Defense) in the development and implementation of computer aided tools for the high fidelity modeling of human motions and activities. These models can be used pro-actively in job design, providing a safer workplace for American workers and military personnel.
- Professors Yili Liu and Nadine Sarter are involved in several projects on the topic of multi-task cognitive modeling. A major goal of this research is to reduce errors and improve human performance and systems safety on jobs that require complex human-machine interactions.
- Adjunct Professor Paul Adams is working with the American Water Works Association Research Foundation and the Environmental Protection Agency to improve safety performance in the water utilities industry.

## **F. Future Plans**

We had successful recruiting for the 2007-08 academic year, and our current enrollment stands at 25 students (6 Masters, and 19 Ph.D.). We are pleased that three new Ph.D. students started their programs this fall. We will continue to recruit Masters students for the Winter 2008 term, and hope to enroll 1-3 additional students in January.

We are working with the IOE Department and the College of Engineering to establish a search for a new faculty position in ergonomics and safety. Due to a tight budget year, it is unlikely that this position will be filled during the 2007-08 hiring cycle. However, we anticipate that new faculty positions will be established for the 2008-09 cycle and that this will be a priority hiring target.

## **Progress Report: Occupational Epidemiology (reporting period July 1, 2006 – June 30, 2007)**

**A. Program Title:** Occupational Epidemiology Training Program

**B. Program Director:** Howard Hu, MD, MPH, ScD

### **C. Program Description**

#### ***Goals and Objectives***

The program in occupational epidemiology has now been in existence for 6 years and received NIOSH funding for the first time in July 2004. Thus, we completed our third year of funded training in June 2007 and we are currently in our fourth year of funding. Our training objectives remain:

- To more fully integrate the curricula, faculty, and trainees in the Departments of Environmental Health Sciences and Epidemiology for the purpose of strengthening the curriculum and the educational experience of students.
- To strengthen the training in occupational epidemiology methods, as recommended by our site visitors in 2005.
- To recruit a class of masters level students of outstanding quality and to train them for professional careers in occupational epidemiology through didactic instruction, field experiences, and interdisciplinary interaction.
- To recruit outstanding doctoral students in occupational epidemiology, give them outstanding didactic instruction, mentor them in the conduct of original research, and prepare them for research careers in occupational epidemiology.
- To recruit trainees from underrepresented racial and ethnic groups

### **D. Program Activities, Accomplishments, and Program Products**

#### ***Faculty Development***

As noted in our 2005-2006 progress report, we undertook a substantial expansion and re-alignment of our faculty in response to the pink sheet we received after our program review in 2005. We noted that a development that addresses the recommendation from reviewers that the OE program recruit additional occupational epidemiology-specific faculty and integrate more strongly with the Department of Epidemiology is the recruitment of a new Chair and tenured full Professor for the Department of Environmental Health Sciences (EHS), Howard Hu, MD, MPH, ScD, who holds a doctoral degree in epidemiology from the Harvard School of Public Health and has spent his career in the field of occupational epidemiology, as well as Marie O'Neill, PhD, as a new Assistant Professor of Environmental Health Sciences and Assistant Professor of Epidemiology (joint appointment). Dr. O'Neill holds a doctoral degree in epidemiology.

In the past year, the former program director, Dr. Garabrant, retired on June 30, 2007. He will continue as an emeritus professor with a full-time research agenda and funding. Dr. Hu, the new Chair of EHS, became the Program Director on July 1, 2007. He has a joint appointment in Epidemiology and is taking an active lead in coordinating our EHS department with the Epidemiology department in terms of faculty commitment, course development, and Web site development. Dr. Hu is an expert in occupational/environmental epidemiology with a long history of training doctoral students, masters students, post-docs, and K-grantees while at the Harvard School of Public Health. Our new junior faculty member, Dr. O'Neill, developed a new course in occupational and environmental epidemiology, which was taught in the winter 2007 term. Another new faculty member has been added, Sung Kyun Park, Sc.D., Research Assistant Professor of Environmental Health Sciences (as of 9/1/07), who has conducted ground-breaking epidemiologic studies of particle effects on cardiovascular disease.

In addition to these critical additions to our faculty, we have been working closely with the Chair of Epidemiology, Hal Morgenstern, PhD, to integrate more closely the epidemiology and environmental health science students who have interests in occupational epidemiology. As a reflection of his increased input into this interdisciplinary program, he was given an appointment in EHS during the past year and has joined the Steering Committee of the OE program. Dr. Morgenstern himself is an expert in occupational epidemiology. We have also added, from the Department of Epidemiology, Dr. Soliman, an expert in occupational cancer epidemiology, and Dr. Mary Haan, an expert in aging and epidemiology has been collaborating on studies of occupational health in aging workers. Finally, we have added faculty from the Department of Biostatistics, Assistant Professor Bhramar Mukherjee, an expert in gene-environment interactions, and Research Assistant Professor Brisa Sanchez, an expert in structural equation modeling. Drs. Mukherjee and Sanchez form the nidus of an Occupation-Environmental Biostatistics unit that will be assisting OE faculty and trainees in developing and applying ever more sophisticated approaches towards the design of our studies and analysis of our data.

Overall, we have dramatically augmented our faculty in occupational epidemiology and have achieved a high degree of integration with the Department of Epidemiology, as was recommended by the site visitors in our recent review, and created new collaborations with faculty in the Department of Biostatistics. We plan to continue development of the OE curriculum as the new faculty develop new courses and modify existing courses in response to changing needs of trainees in OE. Drs. O'Neill, Park and Hu will play critical roles in defining new areas of instruction and research. Drs. Franzblau, Hu, O'Neill, Robins, Meeker, Garabrant and Park will continue with their ongoing funded research programs.

### ***Honors and Awards***

**Professor Franzblau** was honored in January 2007 for his work on evaluation of digital chest radiographs for pneumoconioses by giving the keynote address to a meeting in South Africa on interpretation of radiographs for pneumoconiosis. **Professor Garabrant's** work on meta analysis of mesothelioma risks to motor vehicle mechanics was noted as a major work on asbestos fiber toxicity in the Annals of Occupational Hygiene commentary on achievements over the past 10 years. Professor Garabrant received the Excellence in Research Award from the University of Michigan School of Public Health in April 2006. This award is made annually to a single faculty member in recognition of outstanding research accomplishments. **Professor Hu** received the 2006 Harriett Hardy Award from the New England College of Occupational and Environmental Medicine, became, in 2007, a member of the Board on Population Health and Public Health Practice of the Institute of Medicine, National Academies of Science, and in May of 2007 became the first holder of the NSF International Endowed Chair of Environmental Health Sciences at the University of Michigan School of Public Health. **Professor O'Neill** was elected to a 3 year term as a Councilor for the International Society for Environmental Epidemiology. **Professor Meeker** was awarded the Young Clinical Scientist Award from the Flight Attendant Medical Research Institute for 2005-09. **Professor Haan** has been responsible for reforming the EPID MPH curriculum, publishing in Nature and in the Neurobiology of Aging.

### ***Enrollment, Student Research, and Curriculum***

In the past year we enrolled a total of 14 students (9 masters and 5 doctoral) in occupational epidemiology (OE). In addition to these students, we are in the process of enrolling a new class of students in the Executive Masters Degree in Environmental Health Sciences, which will include additional students with interests in occupational epidemiology. We expect that as a result, our enrollment in OE will be larger as this class forms. During the past academic year, we

graduated 2 doctoral students and 8 masters students. Our research program achieved outstanding productivity, with 23 publications, abstracts, and presentations at scientific meetings by occupational epidemiology trainees. These are listed in Appendix D.

The curriculum in OE has now achieved strength in field training, as we have built the program over the past four years. Our masters trainees are required to complete a field experience during the summer between their first and second years. Examples of field experiences this past year include assessing beaches for recreational water quality standards and a research investigation of to reduce childhood asthma symptoms in Michigan.

We continue to revise and improve the occupational epidemiology curriculum in response to new opportunities as well as the site visitors' comments. As noted in our last progress report, we increased the amount of methodologic content, by requiring students to take EPID 600 Introduction to Epidemiology, followed by a new course EPID 601 Principles and Methods in Epidemiology. We now also offer a course specific to Occupational-Environmental Epidemiology, EHS 608, taught by Dr. O'Neill, and a new course in advanced Environmental Epidemiology Data Analysis will be offered in the Winter session this year by Drs. Park and Sanchez. OE students participate in the joint Departments of Environmental Health Sciences and Epidemiology poster session, which provides increased interaction with IH, HSAT, and Epidemiology students. The poster session is one of the highlights of the students' experience, bringing students together to discuss their research and to learn research approaches in other disciplines. The consequence of these curriculum changes is to strengthen the training in epidemiology methods and to give the students practical experience in the conduct of occupational epidemiology, which reinforces their didactic training.

### ***Training in the Responsible Conduct of Research***

All OE trainees are required to complete the Program for Education and Evaluation in Responsible Research and Scholarship ([PEERRS](#)), which is a web-based instruction and certification program for all members of the University of Michigan community engaged in or associated with research. There are five modules, each of which consists of 20-30 web pages containing the core material, short case studies with questions, and pop-ups with additional information to provide greater depth and elaboration. The modules are: 1) *Foundations of Responsible Research Conduct* (publication/authorship, intellectual property, conflict of interest, signatures, plagiarism, misconduct reporting); 2) *Research Administration* (UM procedures/forms, PI responsibilities, pre- and post-award activities, federal regulations, important contacts); 3) *Conflict of Interest* (definitions and recognizing potential conflicts, responsibilities toward students/colleagues, consulting and conflict of commitment, sponsored project and technology transfer issues); 4) *Human Research* (basic module provided in three versions -- clinical research, health sciences and social/behavioral sciences. It covers definition of human subjects research, why human subjects research is regulated, regulatory and ethical responsibilities of the PI, IRB, and University); 5) *Animal Research* (principles and regulations for animal care and use, regulatory and ethical obligations of researchers, reporting requirements, obtaining approval). After completing each module the trainee must achieve PEERRS certification (valid for three years), which is based on passing a short test (5-10 questions) associated with each topic with a score of 80% or better. The Human Subjects modules require a score of 100% to pass. The tests are generated randomly from a bank of questions developed for each module.

### ***Trainee Recruitment***

The OE program continues to evolve in its approach to recruitment, focusing increasingly on web-based approaches. We continue to develop the OE website within the UM School of Public

Health website and link it to many related sites within the University of Michigan, including the ERC, IH, HSAT, OHN, HSE, the Center for Risk Science and Communication, Toxicology, Environmental Science, and Epidemiology websites. We believe that our website is now the principal portal through which applicants learn about our training program. In addition, we maintain traditional recruiting approaches including advertising in professional journals; printed materials sent to undergraduate colleges, universities, alumni, business, and contacts; and listing our program in traditional graduate school directories such as Peterson's Guide to Graduate schools. We actively recruit racial and ethnic minority students and our recruiting materials emphasize this commitment by the University of Michigan. Our website provides links to student organizations at the SPH that play critical roles in recruiting and retaining minority graduate students including La Salud (a resource for leadership and professional development for Latino/a students) and Public Health Students of African Descent (PHSAD) (a resource for African American students).

#### **F. Future Plans**

We plan to continue development of the OE curriculum as the new faculty develop new courses and modify existing courses in response to changing needs of trainees in OE. Drs. Hu, O'Neill and Morgenstern will play critical roles in defining new areas of instruction and research. Drs. Franzblau, Hu, O'Neill, Robins, Garabrant, and Park will continue with their ongoing funded research programs, which include:

**Case-Control Study Of Leukemia And Lymphomas In An Automobile Transmission Manufacturing Plant.** Principal Investigator: Garabrant, David. Sponsor: United Auto Workers/Ford Motor Company National Joint Committee for Health and Safety.

**Case-Control Study Of Lung Cancer In Automobile Assembly Plants.** Principal Investigator: Garabrant, David. Sponsor: United Auto Workers/Ford Motor Company National Joint Committee for Health and Safety.

**Case-Control Study Of Pancreas Cancer Examining The Roles Of DDT And Other Chlorinated Pesticides.** Principal Investigator: Garabrant, David. Sponsor: NCI/NIEHS

**Cohort Mortality Study Of Automotive Manufacturing Workers in Transmission and Chassis and Stamping Plants.** Principal Investigator: Garabrant, David. Sponsor: United Auto Workers/Ford Motor Company National Joint Committee for Health and Safety.

**DEARS Recruitment Study.** Principal Investigator: Robins, T. Sponsor: EPA

**Dioxin Exposure Study Examining Exposure Pathways By Which Environmental Sources Of Dioxins Contribute To Serum Dioxin Levels.** Principal Investigator: Garabrant, David. Sponsor: Dow Chemical Company.

**Evaluation of Digital Chest Radiographs for Pneumoconioses.** Principal Investigator: Franzblau, A. Sponsor: American Schools of Public Health

**FAMU and Harvard Center for Health and Health dCare Disparities.** Principal Investigator: Hu, Howard (of the Center's Research Project). Sponsor: NIH/NCMHD.

**Fetal Lead Exposure, Genes, and Neurodevelopment.** Principal Investigator: Hu, Howard. Sponsor: NIH/NIEHS

**Gene-Metal Interactions and Parkinson's Disease.** Principal Investigator: Hu, Howard.  
Sponsor: NIH/NIEHS.

**Lead Biomarkers, Aging, and Chronic Disease.** Principal Investigator: Hu, Howard. Sponsor:  
NIH/NIEHS.

**Metals Mixtures and Children's Health (Center for Children's Environmental Health and  
Disease Prevention Research).** Principal Investigator: Hu, Howard. Sponsor: NIH/NIEHS.

**Michigan Center for the Environmental and Children's Health - Exposure Core.** Principal  
Investigator: Israel, B/Robins TG. Sponsor: NIH/EPA

**Noise, Lead and Age-Related Hearing Loss.** Principal Investigator: Park, Sung Kyun.  
Sponsor: U of M NIOSH ERC pilot project

**Post-Offer Screening and Risk Factors for CTS.** Principal Investigator: Franzblau, A.  
Sponsor: Washington University/NIH.

**Prospective Cohort Study Of Chlorpyrifos Manufacturing Workers.** Principal Investigator:  
Garabrant, David. Sponsor: Dow Chemical Company.

**Research Training in Environmental and Occupational Health in Southern Africa.** Principal  
Investigator: Robins, T. Sponsor: NIH/Fogarty Center.

**Study of Lead Exposure & Outcomes Amongst Children in Chennai, India.** Principal  
Investigator: Hu, Howard. Sponsor: NIH/FIC.

**United Automobile Workers Hazardous Materials Worker Health and Safety Training**  
Principal Investigator: Robins, T. Sponsor: International Union, UAW

Additional research proposals are in various stages of planning and seeking funding. We will continue to integrate the departments of Environmental Health Sciences and Epidemiology in research, teaching, faculty interactions, and student interactions. Additional efforts are in progress to augment our recruitment activities, including website development, outreach at undergraduate campuses, and advertising of our program. We also are developing a network of alumni and mechanisms for career development for our graduates to insure that they have outstanding opportunities upon graduation.

## Program Progress Report

### A. Hazardous Substances Academic Training Program

**B. Program Director: Stuart A. Batterman, Ph. D. , Professor**

### C. Program Description

*Goals and objectives.* The objective of The University of Michigan (UM) Hazardous Substances Academic Training (HSAT) Program is to maintain and enhance the specialized academic program that emphasizes hazardous substance health and safety training for occupational safety and health professionals. The program responds to the well-recognized need for qualified industrial hygiene (IH) graduates specializing in the hazardous substances area in the region served by the Michigan ERC. The curriculum provides a comprehensive and solid grounding in the principles and practices of occupational safety and health for professionals in or entering the hazardous substance work force. The HSAT Program complements and enriches the IH program by providing training in hazardous substances, including environmental chemistry, environmental impact assessment, advanced topics in exposure and risk assessment, emergency response, 40-hour HAZWOPER training, hazardous substances management including current and best practices, and research in the IH, environmental health, and hazardous substances area. Program electives allow tailoring of coursework to the trainee's background and interests. The HSAT Program is devoted to master's level training. Qualified program graduates can pursue doctoral work in IH or elsewhere in the Department of Environmental Health Sciences.

Goals of the HSAT Program are to develop both technical and non-technical skills of students; to integrate concepts and problem-solving approaches from industrial hygiene, engineering, and other public health disciplines; and to increase the interdisciplinary knowledge and activity of students, both among the ERC programs as well as pertaining to the sources, fate and remediation of hazardous substances in the environment. These goals are facilitated in the HSAT Program by activities that include: (1) needs assessment; (2) curriculum and program development; (3) student recruitment; (4) implementation, including trainee advising, administration and reporting; and (5) program evaluation.

*Responsible conduct of science training.* The University of Michigan is committed to the highest standards of ethical conduct in education and research. Faculty have the responsibility to ensure the highest level of integrity and ethical conduct in any research conducted under their supervision. A combination of formal training, testing, mentor oversight, and committee oversight is used to ensure that scientific integrity and ethical principles are upheld in research performed, and to instill an awareness of the importance of these issues in our trainees. All investigators on research (students, staff, and faculty) must complete modules in the UM Program for Education and Evaluation in Responsible Research and Scholarship (PEERRS), a web-based instruction and certification program (<http://www.research.umich.edu/training/peerrs.html>). These modules and certification tests can be accessed by all UM faculty, staff and students to improve their knowledge and awareness of responsible research practices. All HSAT students are required to pass the relevant certification tests provided by PEERRS prior to engaging in research, and all students engaged in research involving human subjects are required to submit their proposals to the relevant UM Institutional Review Boards (IRBs) for review. All researchers (including faculty, staff and students and regardless of whether human subjects are involved or not) must pass tests in modules addressing (1) Foundations of Responsible Research Conduct, which deals with legal and ethical requirements of researchers as they relate to authorship and intellectual property (e.g., conflict of interest, misconduct, plagiarism); and (2) Human Research, which deals with regulatory and ethical underpinnings of the policies in place that guide the IRB and its policies and procedures. This module covers why human research is regulated, with emphasis on the regulatory and ethical responsibilities of the principal investigator, Institutional Review Board, and university. Additional modules may be required depending on the nature of the research. Typically, students work with faculty mentors to develop research protocols,

write informed consent documents, prepare IRB applications, and ultimately collect data on human subjects. Thus, where research involving human subjects is involved, trainees play a significant role in completing the IRB application. These are common, routine and institutionalized procedures for HSAT students engaged research, either part-time during the academic year, or full-time during the summer as part of their Field Experience.

Because we believe that students must understand and appreciate the importance and sensitivity of ethical issues in science, we have since 2004 required formal training that address both ethical and legal issues for all EHS MPH students, including HSAT students. Students must successfully complete the key PEERRS and IRB modules, that demonstrate an understanding of Institutional Review Board procedures (i.e., use of human subjects in research), and the Health Insurance Portability and Accountability Act of 1996 (HIPAA, addressing privacy concerns). These and other topics regarding the responsible conduct of science are also discussed in seminar and lecture. Students must send the electronic certificate indicating a “pass” on these PEERRS and IRB modules to the EHS student services coordinator, where it becomes a prerequisite for graduation. Students typically complete these modules during their first year and before their summer Field Experience. No academic credit is provided for these modules. In addition, lectures and reading materials on ethics included in classes such as EHS 550 and EHS 600, and a code of conduct outlining expected elements of academic integrity is circulated and discussed in every course in the HSAT curriculum.

*Faculty participation.* The HSAT Program benefits from the diversity and excellence of participating faculty who are drawn from multiple units at the University of Michigan. These faculty teach HSAT specialty courses, advise students regarding courses, and provide supervision for the students’ Field Experience and research activities. They have shown exceptional commitment to excellence in research and teaching, and all have achieved professional recognition for their activities. Participating faculty actively publish peer-reviewed papers, technical reports, books and book chapters (sometimes co-authored with HSAT students), and they have extensive national and international service. Highlights of key faculty currently participating in HSAT teaching, research, and advising are summarized below. All of these individuals are full-time and tenured or tenure track faculty.

Stuart Batterman, Ph.D., is an environmental scientist/engineer with extensive experience in the hazardous substances area, including RCRA and CERCLA applications. He has served as HSAT Program Director since program inception in 1993, and he continues to provide program management and leadership. Dr. Batterman has been a full time member of the EHS faculty since 1989. His previous committee responsibilities at UM have included Associate Chair for Academic Affairs in EHS, SPH Advisory Committee on Academic Affairs, and EHS Curriculum Committee Chair. He has advisory responsibilities to other UM university entities involved in or related to hazardous substances, including the Center for Sustainable Systems (in the School of Natural Resources, SNRE), and the new Graham Environmental Sustainability Institute (which spans eight schools at UM). He has joint appointments as Professor of Environmental and Water Resources Engineering in the College of Engineering (COE), and until January 2008, as Professor of Mechanical Engineering at the University of Coimbra, Portugal. His courses are cross-listed in SPH, COE and SNRE. He is well positioned to facilitate HSAT curriculum initiatives within the Department, SPH, and the university overall. He has extensive experience and interests in the hazardous substances area, including RCRA and CERCLA applications, e.g., service for Michigan’s Site Review Board for its Hazardous Waste Management Act 64, Advisory Board Member for the Great Lakes Environmental Justice Program, Technical Advisor for Superfund cleanups and incinerator permitting, and expert witness and consultant regarding cleanups and risk assessments in both national and international settings. Recent work addresses medical waste management and disposal in Africa for World Health Organization, Fogarty International Centers of NIH, the Centers for Disease Control, and others. Previously he was Associate Editor for ASCE Journal of Environmental Engineering. Dr. Batterman regularly provides continuing education courses, both nationally and internationally, in air sampling, air pollution control, exposure assessment, risk management, indoor air quality, and other topics. His

expertise includes methods for measuring hazardous substances in air, water, and soil; the transport and fate of volatile organic compounds in air and soils; air toxics; indoor and ambient air quality; exposure and risk assessment, and environmental epidemiology. He teaches EHS 680 - Environmental Management of Hazardous Substances, and EHS 572 - Environmental Impact Assessment.

Participating faculty include the IH Program faculty (Profs. E. Zellers, J. Vincent, J. Meeker), other EHS faculty (especially Profs. J. Nriagu, C. Xi, O. Jolliet, and T. Robins, ), and faculty in other units (Profs. J. Bulkley, G. Keoleian, W. Weber, among others). (Please see IH Program report for a summary of the IH faculty.)

Olivier Jolliet, Ph.D., is associate professor who joined the EHS Department in 2005. His research and teaching addresses environmental risks and impacts of chemicals and of innovative technologies. He co-initiated the UNEP (United Nations Environment Program)/SETAC Life Cycle Initiative and is the scientific manager of its Life Cycle Impact Assessment program. He is one of the principal members in the SPH Center for Risk Sciences and Communication. He teaches EHS 508 - *Principles of Risk Assessment*, and EHS 600 - *Professional Perspectives in Environmental Health*.

Dr. Jerome O. Nriagu, Sc.D., is an environmental chemist, full professor in EHS, Research Scientist in the Center for Human Growth & Development, and Faculty Associate of the Center for African and African American Studies, all at the University of Michigan. His research focuses on the sources, fate and effects of toxic metals in the environment, including biomonitoring and effects of arsenic contamination in groundwater. Dr. Nriagu is one of the most cited scientists in area of environmental chemistry, and he is long-standing editor of *The Science of the Total Environment*. He teaches EHS 574 – *Environmental Chemistry*.

Dr. Chuanwu Xi, Ph.D., is an assistant professor who joined the EHS Department in 2005. He is a molecular microbiologist interested in biofilms and water quality, and the use of molecular and genomic tools to understand molecular mechanisms of persistence and resistance of pathogens in natural, engineered and industrial environments with applications to their impacts on the health of the general public and industrial workers. He teaches EHS 570 - *Water Quality Management*.

Dr. Thomas Robins, MD, MPH, is a full professor in EHS and ERC Director. His major research interests are in neurotoxic and nephrotoxic effects of organic solvents, environmental epidemiology, evaluation of H&S training programs, and international health. He has served lead roles in the development and evaluation of courses for hazardous material workers, and he teaches EHS 507 - *Exposure Assessment*.

Dr. Jonathan Bulkley, Sc.D., is the Peter M. Wege Professor of Sustainable Systems, Professor of Natural Resources, and Professor of Civil & Environmental Engineering. Previously, he directed the Corporate Environmental Management Program (CEMP). Currently he co-directs the Center for Sustainable Systems (CSS). His specialty is water policy and risk-benefit analysis, including both quantitative and qualitative methods. Dr. Bulkley teaches NRE 595 - *Risk Benefit Analysis*, an option for HSAT students.

Dr. Gregory A. Keoleian, Ph.D., is associate professor in the School of Natural Resources and the Environment and the co-director of the Center for Sustainable Systems (CSS). His research and teaching focus addresses the application of systems-oriented approaches to environmental assessment and management, including life cycle design, life cycle assessment, and industrial ecology. Dr. Keoleian teaches NRE 537 - *Industrial Ecology*, an option for HSAT students. Dr. Walter J. Weber, Ph.D., is the Gordon Maskew Fair and Earnest Boyce Distinguished Professor in Chemical Engineering. His research and teaching address characterization and modeling of contaminant transport and transformations in natural and engineered systems, including surface and

groundwater cleanups. He teaches ENSCEN 686 - *Environmental Sustainability*, an option for HSAT students.

*Curricula.* The HSAT Program is a 2-year residential MPH program in which students spend four academic terms on campus and complete a supervised Field Experience (i.e., internship) of at least 10-week's duration in an industrial or other professional/research setting during the summer between the two academic years. The Field Experience must be relevant to the HSAT program objectives. Coursework provides competencies in industrial hygiene along with comprehensive understanding of hazardous substances in occupational and environmental settings, including site remediation, worker protection, exposure and risk assessment, hazardous substances management, hazardous waste law, environmental chemistry, environmental impact and risk assessment, and HAZWOPER training. To meet these goals, the HSAT curriculum modifies the IH Program curriculum with additional course work to provide knowledge, skills and expertise in hazardous substances management, control, regulations, on-site response, risk assessment issues, and in-depth treatment of environmental sampling, analysis, monitoring and assessment activities. Further training is provided in environmental impact assessment, life cycle assessment, and other advanced tools and techniques pertaining to the management of hazardous substances.

Students complete off-site 40-hour HAZWOPER training, most typically during the spring break of their first year (or sometimes during the summer period), with partial defrayment of training expenses by the HSAT Program.

The overwhelming majority of HSAT students elect the MPH degree option, with required core courses in biostatistics, epidemiology, exposure assessment, risk assessment, air sampling and analytical methods (lecture and lab), management, toxicology, occupational diseases, ventilation, safety, radiation, occupational law and policy, ergonomics, noise and other physical hazards, in addition to the HSAT Program specialty courses summarized above. All MPH students are required to take two SPH "breadth" courses (one in health behavior and health education and one in health management and policy) and an integrative, interdisciplinary EHS capstone course. The MPH is a 60-credit-hour degree program, however, the HSAT Program requires a minimum of 64 credit-hours. The EHS Program structure allows the HSAT Program to be offered as a MS degree, although this has not been utilized for several years. The HSAT curriculum is shown in Appendix HSAT-A.

We do not offer the HSAT Program in our non-residential (part-time) OJ/OC program. The HSAT Program support is limited to master's level candidates. There is no undergraduate program, and no Ph.D. support is provided. (Support may be available for students interested in doctoral research in HSAT-relevant research from other sources, but it is not provided by the HSAT Program.)

#### **D. Program Activities and Accomplishments**

*Student recruitment:* We have been successful in recruiting students, and the (2006-7) HSAT cohort included 11 students. We are committed to diversity and aggressively recruit women and minorities. In the past few years, we have recruited about one-third to one-half women and several minority students, including African Americans. All of our continuing HSAT students were placed in relevant internships during the summer of 2006.

*Trainee honors, awards, scholarships.* Our students have received a number of awards over the past year, including: AIHF Ralph Smith Endowed Scholarship Award—Pamela Dopart; AIHF Michigan IH Society Scholarship—Jennifer Hsu; MIHS Award—Matthew Johnson; 2006 EHS MPH Poster Competition, Honorable Mention—Hollie Quisenberry and Ryann Fischer; In the current cohort of HSAT students, one received a Graduate Student Instructorship, two received School of Public Health (SPH) scholarships; and one received a SPH/UM diversity award.

*Faculty honors and awards.* Professor Batterman made invited presentations at the Workshop on the Interpretation of Biomonitoring Data (Minneapolis, MN, July 26-27, 2006), and at the Annual Infection Prevention and Control Meeting (Maputo, Mozambique, June 4, 2007). He was a primary mentor in two award-winning posters presented at the National Public Health Conference (Johannesburg, South Africa, May 16-17, 2006). He was also appointed Professor of Mechanical Engineering at the University of Coimbra, Portugal during his sabbatical, a significant honor.

*New faculty positions.* Four faculty were hired into the EHS Department in 2005, including a new Chair (Howard Hu); assistant professor Marie O'Neill was hired in fall 2006 (50% EHS appointment) with expertise in environmental exposure assessment and epidemiology; and assistant professor Nil Basu was hired in fall 2007 with expertise in exposure biomarkers. These faculty have or will contribute to the HSAT Program through teaching, mentorship, and/or by expanding the scope of research accessible to students.

*New courses.* Several new courses were developed or significantly modified: NURS 606 – Management for Occupational & Environmental Health and Safety Professionals. EHS 657 – Advanced Exposure Assessment (J. Meeker) EHS 600 – Professional Perspectives in Environmental Health (O. Jolliet); Life Cycle Assessment: Human Health and Environmental Impacts (O. Jolliet). These courses are either required or are electives for HSAT students.

## **E. Program Products**

The core HSAT Program faculty produced 28 peer-reviewed papers and conference proceedings papers published or presented over the past year (Appendix HSAT-B). As in previous years, Prof. Batterman taught in the continuing education course entitled “Comprehensive Review of Industrial Hygiene”, which was offered twice last year and has been extremely successful in attracting enrollment. Additionally, he participates in the annual Warren Cook Memorial IH Discussional each October.

HSAT faculty research funding has included support from US EPA, Centers for Disease Control, Great Lakes National Program Office, National Science Foundation, American Chemistry Council, and CRDF (State Department). Dr. Batterman is also co-PI on two major RO1s and an EPA STAR grant that begin in Fall, 2007. All of these projects involved support of, and participation by, students.

## **F. Future Plans**

*Planned initiatives.* Several academic initiatives are planned for this next year. In conjunction with the IH program, we are exploring joint initiatives with a laboratory course (EHS 653). We are also expanding our interdisciplinary training by modifying our current capstone course, EHS 600, to engage students in multidisciplinary projects to characterize or solve a practical problem. We are exploring the possibility of increasing our visibility and activity in environmental sustainability. Finally, with the arrival of a new faculty (Richard Jackson) to head the new UM Graham Environmental Sustainability Program, and a new program in Environmental Law and Policy (another new appointment in Law, David Uhlmann), we will be exploring ways to expand the environmental management and law offerings to our HSAT students.

### **III.A. Program Title: Continuing Education and Outreach**

This is the annual report for the Continuing Education and Outreach (CE&O) program, addressing July 1, 2006 through June 30, 2007. The Michigan ERC has one funded program covering both Continuing Education (CE) and Outreach, so this annual report section will correspondingly cover both CE and Outreach. There is one centralized CE and Outreach department to serve all Michigan ERC academic areas. This report will integrate the activities for all academic areas.

### **III.B. Program Director**

The Michigan ERC CE&O Program is directed by Mr. Randall Rabourn, who has a strong academic and professional background in occupational health and safety and has directed the Michigan ERC's CE&O program since 1985. He is a Certified Safety Professional and a Certified Professional Ergonomist.

### **III.C. Program Description**

The general goal for Continuing Education and Outreach is to provide current occupational health and safety information to those who can affect workplace health and safety. This audience includes occupational health physicians and nurses, industrial hygienists, safety personnel, managers, supervisory personnel, workers, labor representatives, and various occupational healthcare-related professionals. Specific CE annual goals are to: conduct at least 15 courses annually with at least 2 programs attributable to each of the ERC's core disciplines; train more than 400 people; have 10 ERC faculty and staff participate; and assess continuing education needs via open website surveys or other methods. Specific annual outreach goals include: involve at least 10 ERC faculty and staff in outreach activities by providing academic support, lectures and consults to benefit non-ERC individuals and organizations; exhibit at 1 or more professional conferences; maintain an ERC website to advertise our academic and continuing education activities; and issue email announcements about our programs and activities.

The CE&O program is partially funded by the NIOSH ERC grant, with other support derived from course registration fees. The NIOSH grant provides a base of support (although fractional) for the program director, a conference coordinator and program logistics support personnel. This base is important since it allows us to attract support from other sources, effectively leveraging the NIOSH funding. Our current NIOSH grant does not provide separate budgets for CE and Outreach activities. Most of the CE&O budget is assigned to CE activities and outreach activities are largely conducted by individual faculty and staff with little direct NIOSH financial support.

Further Information about Continuing Education: A dedicated and committed program faculty and support staff conducts the CE programs. These individuals have demonstrated this commitment over many years of active participation in Michigan CE programs. This past year we continued to have strong participation by our ERC faculty as planners, directors and lecturers in our programs. Faculty support is a major strength of our CE activities. Our faculty members have high academic credentials and are nationally and internationally recognized for work performed in their individual areas of expertise. The School of Public Health, the College of Engineering and the School of Nursing which house these individuals, have consistently been ranked among the best in their fields. Detailed biographical and professional information attesting to the excellent reputation and strength of these individuals is included in report sections devoted to the academic disciplines or in the recent competing renewal applications submitted in 2004 and 2007. Generalized statements about our faculty include: most are tenured, senior-level faculty members; they are active professionally and are leaders and fellows in national professional organizations; some are involved in regional and

national occupational health and safety standards activities; some are involved in setting up occupational health and safety programs for other nations; and even emeritus faculty continue to participate in our activities.

Our strong and respected ERC faculty allows us to identify, attract and utilize complimentary national and international experts (typically 60-80 annually) for guest lectures and presentations. This expands our ability to cover a broad range of topics in high quality continuing education programs that the Center is proud to sponsor. In the minority of our programs where ERC faculty members are not delivering the course, programs and program faculty are carefully selected, utilizing referrals from reputable sources, such as ERC faculty, colleagues, professional organizations and other ERCs. A further testament to the strength of our faculty comes from course evaluations and surveys where many program attendees indicate that faculty quality is a major reason for attending our programs.

Several of our programs are aimed at multiple core disciplines. This results in fractional counting (and multiple listing) of courses summarized in Appendices CE-1 and CE-2, but in no event is a course counted more than once. Even though our ERC has no OM program, physicians are targeted by our multidisciplinary programs and we also direct them to on-line training opportunities offered at other ERCs via our website.

We find it effective to enlist the support of professional groups and universities via program co-sponsorship. This allows us to reach a larger audience by pooling mailing lists and personal contacts and is an important mechanism to leverage NIOSH funding. We secure continuing education credits and issue certificates of attendance to program attendees.

Many different mechanisms of needs assessment are utilized to help shape the courses we offer. We use the results of the large CE surveys we conducted and compiled near the end of 2004 and more recently in 2007. We participate in needs assessment surveys administered by the ERC Continuing Education Directors at national occupational health and safety conferences. We also conduct an on-going electronic needs assessment survey on our Michigan ERC website. (A copy is not included here, but can be accessed at [www.umcohs.org](http://www.umcohs.org).) We also participate in the NIOSH ERC website ([www.niosh-erc.org](http://www.niosh-erc.org)) needs assessment survey.

Other needs assessment methods are also important. We have an on-going continuing education and outreach advisory group comprised of regional representatives from occupational health and safety professions. We maintain close ties to national professional organizations to better understand their members' needs and work with those organizations to offer timely programs. At the conclusion of our continuing education programs we request a program evaluation from all program attendees. Attendees indicate areas of interest or need that they or their associates have which could be addressed in future continuing education programs. This feedback also helps us revise on-going programs. We also gather needs information by less formal methods such as interviews with program attendees. Our active and visible faculty gather valuable information through their professional contacts, which is used in program development.

It is improbable that we will be able to offer programs to address the needs of everyone. In cases where individuals have specific needs that we do not address by our programs, we make efforts to align them with other regional ERCs or organizations that can assist them.

Further Information about Outreach: Limited NIOSH funding was available to conduct large scale, organized outreach projects, yet significant activities occurred, many undertaken on an individual faculty and staff member basis. We engage in diversified outreach activities, including: providing educational development support to assist other academic institutions and units with curriculum or research issues; providing lectures and presentations for numerous organizations and agencies on occupational health and safety topics; providing consultations to organizations to assist them in addressing a multitude of safety and health issues; and providing support to individuals and organizations in many non-categorical ways.

### III.D. Program Activities and Accomplishments

Continuing Education: The Center provided courses aimed at the four academic core areas of industrial hygiene (IH), occupational medicine (OM), safety engineering (OSE) and occupational health nursing (OHN). 1067 people attended the 20 programs we conducted, resulting in 2580 person days of training. Four of these courses were attributable to OS, 2 to OM, 6 to IH and 8 to OHN. Fourteen ERC faculty and staff participated in these programs. We assessed continuing education needs of our target audience via an open survey on our website and by other means. In short, the Center met or exceeded our annual CE goals stated above. (See Appendices CE-1 and CE-2 for a statistical report on the CE programs conducted, Appendix CE-3 for information about each program, and section III.E for more information about the CE “products.”)

Outreach: Eighteen ERC faculty and staff provided a listing of their outreach activities, documenting their participation. We exhibited at 7 professional conferences. We maintained an ERC website. We issued monthly announcements via email to 5500 people about our continuing education and academic programs. These results exceeded our annual outreach goals. A summary of selected accomplishments follow. Detailed listings of individual faculty and staff activities are provided as Appendix Outreach-1 to this report.

*Educational Development:* OM and IH faculty are the foundation for the Michigan Fogarty International Center Programme in Environmental Health Sciences. This large-scale, non-ERC funded project’s purpose is to develop the occupational and environmental health infrastructure and expertise in Southern Africa and involves: 1) financial and intellectual support for candidates from the Southern African Development Community (SADC) for MPH and PhD programs at the University of Michigan, 2) short-term focused training for SADC researchers and health professionals, 3) sponsoring SADC candidates for postgraduate programs at partner institutions in Southern Africa, 4) sponsoring mid-level researchers at SADC institutions, 5) developing web-based learning programs and 6) organizing and funding short-term training courses and conferences in Africa.

Individual faculty representing all core disciplines assisted non-occupational health and safety departments within the University of Michigan by supplying lectures, advice and mentoring of students related to occupational health and safety issues. Of particular note is the IH faculty’s support of the Chemistry Department in these areas plus student recruitment and OS faculty participation in the College of Engineering Curriculum Committee. Other institutions and organizations benefited from ERC support for curriculum development (academic or continuing education) or research support. These would include: Tulane, Marquette University, Michigan State University, Tsinghua University, University of Wisconsin, University of Coimbra, University of KwaZulu Natal, Pusan National University, University of Sao Paulo, Michigan Occupational and Environmental Medicine Association, Northwest Ohio Association of Occupational Health Nurses, and others.

*Presentations/Lectures/Awareness Seminars:* Numerous presentations and lectures were delivered by faculty and staff from all core disciplines on a variety of occupational health and safety topics. Listings can be found in Appendix Outreach-1. Recipients included universities, labor organizations, trade and professional associations, numerous private employers, and high school and university students contemplating safety and health careers.

*Consultations:* Many organizations received consultation support from individual faculty and staff members from all core disciplines. A partial list of activities include: workplace or work system analysis and design support; assist panels, companies, organizations and governments in developing occupational health and safety policies or evaluating impact studies; research support; and legal and management support. Recipients of these consults were both regional and national/international in scope and impacted thousands of workers. Examples of regional recipients include: University of Michigan employee health and safety departments; Michigan OSHA;

Michigan-based automakers; United Auto Workers Union; Society of Automotive Engineers; and numerous Michigan companies. Examples of national or international recipients include: NIOSH; NIDCD; OSHA; National Research Council; US Army; World Health Organization; US National Academies; University of Capetown; University of KwaZulu-Natal; and several large companies. Details can be found in Appendix Outreach-1.

*Other Outreach Activities:* The University of Michigan conducts a sizable training and service project for small businesses in Michigan. This project, funded by a Consultation, Education and Training (CET) grant from the state of Michigan is led by Michigan ERC faculty and staff from the College of Engineering. This outreach activity assists a state agency, Michigan OSHA, by providing on-site ergonomics training to approximately 200 people annually (not included in CE course attendee counts). This project also provides state employers with professional service to identify high-risk workplaces and to assist in developing systems to reduce the risk of musculoskeletal injuries. This project is a valuable resource to Michigan OSHA staff who provide support to regional companies beyond our direct contact. This on-going project has reached more than 2900 people in on-site seminars and over 6000 people via CD-ROM training. NIOSH budget is not used directly for these activities, but the infrastructure provided by the ERC grant is instrumental in obtaining the CET grant.

We maintain a 5500+ member email listserv system to reach large numbers of individuals via e-mail quickly and inexpensively. We use this outreach tool to inform many people about our ERC activities and to recruit students via a monthly announcement. We maintain a Michigan ERC Web site to provide visitors with academic and continuing education information and we field Web site-related telephone and internet inquiries, providing ad-hoc service to individuals in a wide variety of organizations.

We co-sponsor the Applied Ergonomics Conference with the Institute of Industrial Engineers, bringing an academic perspective to a conference devoted to 600 ergonomics practitioners. We also cosponsor the Digital Human Motion conference with the Society of Automotive Engineers, providing an occupational health perspective to a traditional engineering audience. We staffed exhibits at national conferences of the American Industrial Hygiene Association, International Ergonomics Association and Human Factors and Ergonomics Society and at the Digital Human Motion, Applied Ergonomics and National Ergonomics Conferences to promote academic and continuing education opportunities. We exhibited regionally at the Michigan Safety Conference. We develop and maintain two computer software programs for evaluating workplace musculoskeletal requirements which have over 4000 licensees, and discount this software to academic institutions.

The Center entertains visitors and conducts occupational health and safety awareness programs and tours of our facilities. Several OSE faculty and staff arranged tours and presentations for high school students and parents exploring career opportunities, several with a focus on attracting minority groups and women to engineering. We field numerous telephone and internet inquiries on an on-going basis, providing ad-hoc service to individuals in a wide variety of organizations and professions.

Individuals from all ERC core disciplines served in advisory roles to professional organizations and national research organizations and served on editorial boards. This past year, an ERC individual associated with the OSE core co-chaired the Michigan OSHA ergonomics standard Advisory Board.

### III.E Program Products

The products of the CE&O program are the courses and programs we conduct. This past year we conducted 20 courses or programs. Space does not permit a detailed description of each product here, but a summary of each is provided in Appendix CE-3.

There are several programs (products) or program issues deserving special mention. A new program addressing mold issues, Mold Research and Practice: The Realities and the Myths, was conducted at the Michigan Safety Conference. This program was made possible by special NIOSH funding for NORA activities. Another new program, Occupational Biomechanics Symposium: Celebrating 35 Years of Progress and Looking Toward the Future, was conducted in Ann Arbor. This symposium was attended by 120 and brought together leading researchers to discuss: contemporary models; studies that support model use and development; and the impact models have on contemporary design of jobs in manufacturing and other work settings. Developing Accommodations for Employees with Physical Impairments was a new program that explored using ergonomics principles as a means to design work for individuals with special needs. This past year we offered an unusually large number of nursing programs, due in part to the new Physical Assessment for the Occupational Health Nurse offering and a series of 4 courses conducted at the national occupational health nursing conference. In addition to registration fee-paying attendees, we were able to offer 30 scholarships to Michigan small businesses to attend our Ergonomics Principles for Workplace Assessment and Design course. Scholarship funding came from the State of Michigan CET grant (described earlier). The CE infrastructure provided by the ERC grant is important in obtaining this state funding to further serve regional needs.

### III.E Future Plans

The annual goals for CE and Outreach developed as a part of our last competing renewal (and summarized in III.C of this report) will remain in effect for the upcoming reporting year, July 1, 2007 through June 30, 2008. (We also recently submitted a competitive renewal application for continuing our ERC activities beginning July 1, 2008.)

Continuing Education: Several of the CE programs offered in the past year and described in Appendix CE-3 will be offered again in the upcoming year. Some of these programs will have completely new content, such as the Industrial Hygiene Discussional, the Ergonomic Interventions and Research program, and the NORA Symposium, and the program. In addition, new programs in name and content are planned for the upcoming year, including: Preventing and Managing Workplace Musculoskeletal Disorders and yet-to-be titled programs on bioaerosols and addressing the most difficult clinical issues commonly encountered by occupational health nurses.

This aggressive slate of new programs or program content is typical for our ERC. We will use our current CE&O administrative staff to manage these programs and will collaborate with other organizations to leverage our resources. ERC faculty and staff will take active roles in directing and teaching these programs.

Outreach: A wide variety of outreach activities will be accomplished by ERC faculty and staff on an individual performance basis, similar to those described in this report and listed in Appendix Outreach-1. We will assist universities and other organizations with educational and consultative support and will provide presentations to promote occupational health and safety. We will exhibit at multiple occupational health and safety conferences over the next year to recruit academic and continuing education students. We will maintain an ERC website. We will continue our monthly email correspondence with the growing number of people on our listserv system. We have applied for renewal of our State of Michigan CET grant to provide ergonomics training and service to small Michigan companies. If approved, this will allow us to continue our outreach work with these companies throughout the upcoming reporting year.

#### **IV. Report on Specific Improvements in OS&H Resulting from ERC Programs**

**Overview.** ERC faculty have carried out a wide array of research studies, consultations, technology transfers, and training programs regionally, nationally, and internationally, that have had direct beneficial impacts on practices leading to improved worker health and safety. A majority of these can be characterized as Research-to-Practice (R2P) activities.

##### **U.S. Based Projects:**

- The U of M Center for Ergonomics, in cooperation with the State of Michigan, provides ergonomics consulting and training services to small and medium-sized companies. In a typical year, we are able to respond to approximately 12-15 requests for in-plant assistance. During the 2005-06 reporting year, we started a new initiative by involving our Ph.D. students in this program.
- Professors Barry Kantowitz and Paul Green, in conjunction with The University of Michigan Transportation Institute are involved with multiple studies to improve the safety performance of both commercial and passenger vehicles. Because highway crashes continue to be the leading cause of occupational fatalities in the United States, this research has important benefits to the safety of the American workforce.
- Professors Don Chaffin and Bernard Martin are working with a consortium of private sector and federal sponsors (including the Dept. of Defense) in the development and implementation of computer aided tools for the high fidelity modeling of human motions and activities. These models can be used pro-actively in job design, providing a safer workplace for American workers and military personnel.
- Professors Yili Liu and Nadine Sarter are involved in several projects on the topic of multi-task cognitive modeling. A major goal of this research is to reduce errors and improve human performance and systems safety on jobs that require complex human-machine interactions.
- Professor Thomas Robins and doctoral student Mr. Aaron Sussell have worked closely with Adjunct Associate Professor Gordon Reeve, Chief of Epidemiology for the Ford Motor Company, to develop and implement recommendations for the prevention of contact dermatitis among the automotive assembly workers. These recommendations, based on findings of Mr. Sussell's doctoral dissertation "Incidence and Risk Factors for Occupational Contact Dermatitis among Automobile Assembly Workers", have been presented to management and union representatives leading to implementation of improved products selection, improved work practices and improved use of personal protective equipment (gloves and sleeves).
- Dr. Batterman regularly provides continuing education courses both nationally and internationally in air sampling, air pollution control, exposure assessment, risk management, and other topics.
- Dr. Hong received funding of an RO1 Grant proposal to develop an expert system intervention to prevent noise-induced hearing loss in firefighters.

**Notable impacts on International OHS.** Professor Robins is the Director of the University of Michigan/Fogarty International Center Southern African Program in Training and Research in Environmental and Occupational Health (ITREOH). This large-scale, non-ERC funded project's purpose is to develop the occupational and

environmental health infrastructure and expertise in Southern Africa. Methods include, among several others, financial and intellectual support for candidates from the Southern African Development Community (SADC) for MPH and PhD programs at the University of Michigan, and direct funding of research by junior to mid-level researchers at SADC institutions. Fogarty trainees coming to the University of Michigan benefit enormously from the strong research and training environment that the ERC grant funds play a major role in creating and maintaining. This ITREOH grant has a solid track record of translating the results of research into public health practice including influencing the development and implementation of health policies. For example, the research conducted by Dr. Mohamed Jeebhay as a Fogarty UM doctoral student under the direction of Professor Robins on occupational seafood allergies and asthma has contributed directly to the content of the regulations on Hazardous Biological agents promulgated under the Occupational Health and Safety Act in South Africa. His research on baker's asthma has contributed toward a downward revision of the current exposure standards for flour dust. The first study of air pollution and health effects in the South Durban Industrial Basin (South Africa), which formed the basis for the Masters theses of two Fogarty funded students, found that children with persistent asthma were experiencing increased symptoms and decreased lung function with the elevations of SO<sub>2</sub>, PM<sub>10</sub> and NO<sub>2</sub> at levels well within international standards. These findings played a significant role in decisions by the two major oil refinery in the basin to take steps to substantially reduce emissions to improve air quality in the area. A third example is the study of mercury contamination from a large industrial facility outside of Durban conducted by one of the Fogarty trainees (Jacques Oosthuizen). The findings of this study, that mercury levels were relatively low in fish being consumed downriver from the plant but very high in water immediately adjacent to the plant, drove related remediation and lifestyle recommendations.

Professor Batterman conducted an assessment of hazardous/medical waste incineration in South Africa, and a risk assessment was completed for Durban in 2006, both leading to specific recommendations which are currently under implementation.

**Outreach and consultation.** Many organizations received consultation support from individual faculty and staff members across all core disciplines. A partial list of activities include: workplace or work system analysis and design support; assistance to panels, companies, organizations and governments in developing occupational health and safety policies or evaluating impact studies; research support; and legal and management support. Beneficiaries of these consults were both regional and national/international in scope resulting in positive impacts on thousands of workers. Examples of regional recipients of consultations include: University of Michigan employee health and safety departments; Michigan OSHA; Michigan-based automakers; United Auto Workers Union; Society of Automotive Engineers; Korean Drycleaners Association in Michigan; numerous other large companies and more than 10 small Michigan companies lacking in the in-house expertise to address OHS issues. Examples of national or international recipients include: NIOSH; NIDCD; OSHA; National Research Council; United Steel Workers Union; US Army; World Health Organization; US National Academies; University of Cape Town; University of KwaZulu-Natal; University of Sao Paulo College of Nursing; Pusan National University; Eulji University School of Nursing; and several large companies.

## APPENDIX IH-A

### Curricula (Sample Schedules) for IH-MPH (Residential and OJ/OC), IH-MS, and IH PhD Degree Programs

#### MASTER OF PUBLIC HEALTH – INDUSTRIAL HYGIENE

Course No	Course Title	Credit Hrs
<b>Year 1 – Fall Term</b>		
BIOSTAT 503	Introduction to Biostatistics	4
EHS 506	Principles of Toxicology	2
EHS 507	Principles of Exposure Assessment	2
EHS 550	Principles of Industrial Hygiene	2
EHS 652	Evaluation of Chemical Hazards	3
Elective ----	Elective	3
	<b>Sub-Total</b>	<b>16</b>
<b>Year 1 – Winter Term</b>		
BIOSTAT 513	Application of Regression Analysis to Public Hlth Studies	3
EHS 501	Occupational and Environmental Disease	2
EHS 653	Chemical Exposure and Measurement Laboratory	3
EHS 654	Control of Exposure to Airborne Contaminants	3
EHS 668	Occupational Health Seminar	1
EPID 503	Strategies and Uses in Epidemiology	3
	<b>Sub-Total</b>	<b>15</b>
<b>Year 1 - Spring/Summer</b> Field Experience		
<b>Year 2 - Fall Term</b>		
EHS 600	Professional Perspectives in Environmental Health	2
EHS 658	Physical Hazards	1
EHS 757	OH Processes Industrial Processes	2
IOE 539	Occupational Safety Engineering	3
HBHE 600	Psychosocial Factors in Hlth Behavior (SPH-MPH Req.) Research/Electives	3 4
	<b>Sub-Total</b>	<b>15</b>
<b>Year 2 – Winter Term</b>		
EHS 508	Principles of Risk Assessment	2
EHS 556	Occupational Ergonomics	2
EHS 581	Principles of Radiological Health	1
EHS 668	Occupational Health Seminar	1
HMP 653	Law and Public Health (SPH-MPH Req.) Research/Electives	3 6
	<b>Sub-Total</b>	<b>15</b>
	<b>TOTAL</b>	<b>60</b>

\_\_\_\_\_   
All courses listed are required.

**Program Schedule**

**On Job / On Campus Executive Master's Program in Environmental Health Sciences**

Course	Cr.	Title	Instructor	2006			2007												2008					Total	Total	Total	
				Year																							
				Month	Nov	Dec	DL	Feb	DL	Apr	DL	Jun	DL	Jul	DL	Sep	DL	Dec	DL	Feb	DL	Apr	DL				June
Days	8-12	7-10		8-11		12-15		7-10		26-29		27-30		6-9		7-10		3-6		5-8							
		Computer Sessions		4																							
EHS 506	2	Principles Toxicology	Richardson	2	4		2																8	0	<b>8</b>		
BIOSTAT 503	4	Introduction to Biostatistics	Kim	2	4	10	4	10	2														12	20	<b>32</b>		
EHS 507	2	Principles Exposure Assessment	Robins	4	4	2	2	2	2														12	4	<b>16</b>		
EHS 574	3	Environmental Chemistry	Nriagu	6	4	4	4	4	2	2	2												18	10	<b>28</b>		
EHS 550	3	Occupational & Environ Health	Vincent	6	6	4	4	6	4	4	2												22	14	<b>36</b>		
EPID 503	3	Epidemiology	Johnson		2	6	4	6	4	8	2												12	20	<b>32</b>		
HBHE 600	3	Principles of Health Behavior	Sonnega				4		8		8		4										24	0	<b>24</b>		
EHS 581	1	Radiological Health	Miklos				2	4	2	4	2												6	8	<b>14</b>		
EHS 508	2	Risk Assessment	Jolliett				2	4	4	6	2	4	4										12	14	<b>26</b>		
BIOSTAT 513	3	Appl Regression Analysis to Public Hlth Studies	Sanchez Loya							2	8	4	6	2									8	14	<b>22</b>		
EHS 570	3	Water Quality Assessment& Management	Xi							4	8	4	8	2									10	16	<b>26</b>		
EHS 501	2	Occupational and Environmental Diseases	O'Neill								2	6	4	6	2								8	12	<b>20</b>		
HMP 617	3	Understanding Health Care Organizations	Grenawitzke								8	8	4	8	4								16	16	<b>32</b>		
EHS 653	1	Environmental Sampling & Analysis Lab	Xi/Zellers								4	2	4	2	4	2	4						16	6	<b>22</b>		
EHS 658	1	Physical Hazards	Meeker										2	4	4	2	2						8	6	<b>14</b>		
EHS 652	3	Evaluation of Chemical Hazards	Zellers										4	6	4	6	4	6	2				14	18	<b>32</b>		
NURS 606	2	Management for OSEH Professionals	Hong/Strasser												4	6	2	6	4				10	12	<b>22</b>		
EHS 654	3	Control Occ & Env Contaminants	Vincent												2	6	4	6	4	6	4	4	14	18	<b>32</b>		
EHS 552	3	Occupational Safety	Paul Adams												2	4	6	6	6	4	4	4	18	14	<b>32</b>		
EHS 572	2	Environmental Impact Assessment	Batterman												2	4	2	4	4	4	2	10	12	<b>22</b>			
EHS 556	2	Occupational Ergonomics	Joseph														4	4	6	4	4	14	8	<b>22</b>			
EHS 698/600	5	IWP Project	Staff	2	2		2		1		2			6	1		1		1		8	26	0	<b>26</b>			
EHS 688	1	Topics in Environmental Health Sciences	Staff				1		1		1			1		1		1		1		1	8	0	<b>8</b>		
55 -Credit hours in program				Hours in Month	26	22	26	29	36	30	24	27	20	30	30	29	26	30	30	30	32	28	18	23			
				Courses in Month	4	5	5	8	7	8	5	8	3	7	5	7	5	9	7	8	6	8	4	6			

DL - Distance Learning

OC - On Campus

## MASTER OF SCIENCE – INDUSTRIAL HYGIENE

Course No	Course Title	Credit Hrs
<b>Year 1 – Fall Term</b>		
*BIOSTAT 503	Introduction to Biostatistics	4
*EHS 506	Principles of Toxicology	2
*EHS 550	Principles of Industrial Hygiene	2
*EHS 652	Evaluation of Chemical Hazards	3
*EHS 698	Research (or elective relevant to research interest)	3
	<b>Sub-Total</b>	<b>14</b>
<b>Year 1 – Winter Term</b>		
*BIOSTAT 523	Biostatistical Analysis of Health Related Studies	3
*EHS 501	Occupational and Environmental Disease	2
*EHS 653	Chemical Exposure and Measurement Laboratory	3
*EHS 654	Ventilation Contaminant Control	3
*EHS 668	Occupational Health Seminar	1
*EPID 503	Strategies and Uses in Epidemiology	3
*EHS 698	Research	2
	<b>Sub-Total</b>	<b>17</b>
<b>Summer</b>		
	Research	---
<b>Year 2 - Fall Term</b>		
* IOE 539	Occupational Safety Engineering	3
*EHS 658	Physical Hazards	1
*EHS 698	Research	3
*STAT 401	Applied Stat Methods II	3
Elective ----	Elective (optional)	3
	<b>Sub-Total</b>	<b>13</b>
<b>Year 2 – Winter Term</b>		
*EHS 556	Occupational Ergonomics	2
Elective ----	Electives (optional)	6
*EHS 698	Research	4
*EHS 699	Masters Thesis	1
	<b>Sub-Total</b>	<b>13</b>
	<b>TOTAL</b>	<b>57</b>

Required courses are marked with an asterisk. A minimum of 12 credit hours of research must be taken. Other course selections are determined with advisor to meet student needs/interests. A minimum of 48 credit hours is required.

## DOCTOR OF PHILOSOPHY (Ph.D.)

### Departmental Course Requirements

*Select one of the following*

- BIOSTAT 503 (4) Introduction to Biostatistics
- BIOSTAT 553 (4) Applied Biostatistics
- STAT 400 (4) Applied Statistical Methods

*Select one of the following*

- EPID 503 (3) Strategies and Uses of Epidemiology
- EPID 600 (3) Introduction to Epidemiology
- EPID 601 (4) Principles and Methods in Epidemiology

*Select two of the following:*

- BIOSTAT 513 (3) Application of Regression Analysis to Hlth Studies
- BIOSTAT 523 (3) Biostatistical Analysis for Health-Related Studies
- Statistics 401 (3) Applied Statistical Methods II

*Statistics or Biostatistics course (determined with advisor and approval of doctoral committee)*

Cognate Course – One 2-3 credit hour course outside the Department of Environmental Health Sciences (to be determined by advisor with approval of doctoral committee)

- EHS 688 (1) Topics in Environmental Health Sciences<sup>1</sup>
- EHS 899 (≤6) Advanced Research (2 separate rotations required)<sup>2</sup>
- EHS 869 (1) Doctoral Seminar in Environmental Health Sciences<sup>3</sup>

<sup>1</sup>EHS 688 is a departmental seminar that spans the first 2 terms. Students are expected to attend seminars throughout their doctoral program but they do not have to officially register.

<sup>2</sup>EHS 899 - Students complete two separate rotations with different faculty for a minimum of 1 credit each time

<sup>3</sup>EHS 869 is a doctoral seminar that students register for until they have passed their Preliminary Exam. Prior to the Prelim exam, they will present a formal seminar in this class

### Additional Course Requirements

*Select one of the followings*

- EHS 501 (2) Occupational Diseases
- EHS 506 (2) Principles of Toxicology
- EHS 507 (2) Principles of Exposure Assessment
- EHS 508 (2) Principles of Risk Assessment

*Select one of the following:*

- EHS 550 (3) Principles of Occupational and Environmental Health
- EHS 570 (3) Water Quality
- EHS 572 (2) Environmental Impact Assessment
- EHS 574 (3) Environmental Chemistry
- EHS 576 (3) Microbiology in Environmental Health

*500-level EHS course (determined with mentor and approval of doctoral committee)*

*Select 3 of the following courses (or any 600-level course in EHS added subsequently):*

- EHS 608 (3) Environmental Epidemiology
- EHS 612 (3) Biochemical and Molecular Toxicology
- EHS 625 (2) Environment & the Immune Response
- EHS 630 (4) Principles of Nutritional Sciences
- EHS 631 (4) Advanced Nutritional Sciences
- EHS 643 (3) Food & Nutrition Policy & Programs
- EHS 645 (3) Nutritional Education: Theory & Practice
- EHS 652 (3) Evaluation of Chemical Hazards
- EHS 653 (3) Environmental Sampling and Analysis Lab
- EHS 654 (3) Control of Exposures to Airborne Contaminants
- EHS 657 (3) Advanced Exposure Assessment
- EHS 672 (3) Life cycle assessment: Human health and environmental impacts
- EHS 680 (3) Environ Management Hazardous Substances

**Qualifying Examination** – Predoctoral students normally take the EHS Qualifying Examination following their first year in the program, after completion of the required didactic coursework.

**Predoctoral Examination** – Predoctoral students who have passed the Qualifying Examination must pass the Preliminary Examination in order to advance to candidacy. The Preliminary Examination is normally completed during the third year in the program.

## APPENDIX OHN-A

### A. Program curricula including general course requirements for the PhD Program.

#### Appendix A-1 OHN-CNS Master's Degree Course Requirements.

<b>Nursing Core Courses (10 credits)</b>		
<b>Course</b>	<b>Title</b>	<b>Credits</b>
N532	Theoretical Base for Advanced Nursing Practice	3
N535	Strategies for Nursing & Health Care	3
N536	Utilization of Nursing Research in Advanced Practice	2
N699	Nursing Research/Thesis	2
<b>Nursing Specialty Courses (17 credits)</b>		
N537	Health Promotion and Risk Reduction Across the Lifespan	3
N563*	Community Health Nursing and Population assessment	4
N572	Current and Emerging Issues in Occupational Health Nursing practice	2
N606**	Management For Occupational & Environmental Health, and Safety (OEHS) Professionals	2
N686*	Interventions with Aggregates and Communities	4
N687*	Management Practicum	2
<b>Occupational Health and Safety Courses (13 credits)</b>		
EHS501	Occupational Disease	2
EHS506	Principles of Toxicology	2
EHS550	Occupational & Environmental Health	3
EHS552	Occupational Safety	3
EHS556	Occupational Ergonomics	2
EHS668	Seminar in Occupational Health	1
<b>Public Health Core Courses (7 credits)</b>		
BIO503	Introduction to Biostatistics	4
EPI503	Strategies and Uses - Epidemiology	3
	<b>Total</b>	<b>47</b>

\* Clinical practica are essential components of three required courses (N563, N686, and N687).

\*\* New course required by all students in IH, OHN, and OSE

## **Appendix A-2 Nursing Doctoral Program Plan**

The total number of coursework credits required in the doctoral program (not including prelim or dissertation credits), are distributed among the following components:

### **Nursing and Nursing Theory**

#### **Core (15 credits):**

##### **Three-course sequence on theory development (9 credits)**

N532. The Theoretical Base for Advanced Nursing Practice (3 cr.)

N801. Directed Study in Clinical Nursing (3 cr.)

N821. Advance Nursing and Development (3 cr.)

##### **Minimum of one course on issues in health care systems and nursing leadership (3 credits)**

N535. Strategy for Nursing and Health Care (3 cr.)

##### **One course in philosophy of science (3 credits)**

N570. Philosophy of Science (3 cr.) (cross listed as Philosophy 420)

### **Specialization (22 credits)**

#### **Advanced Nursing Practice (13 credits)**

A minimum of 13 credits of advanced courses in clinical areas within nursing (500- or 600- level courses in the School of Nursing, or their equivalent).

#### **Research and Theory in the Concentration Area (9 credits)**

Three nursing courses (9 credits) at the 800- level from the chosen concentration. Students choose courses from one of four concentrations offered. Health Promotion/Risk Reduction, Bio-behavior, Nursing Business & Health Systems, and Women's Health.

### **Research**

#### **Core Courses (16 credits)**

N 536: Utilization of Nursing Research in Advanced Practice (2 credits)

N603: Data Management Analysis & Representation for Advanced Practice in Nursing (2 credits)

N830: Advanced Measurement and Design (3 credits)

N831: Advanced Data Analysis (3 credits)

Two Statistics Courses (6 credits)

#### **Other (3 credits)**

At least one additional course in research methodology or advanced data analysis

#### **Research Projects**

Two research projects are required for completion of the doctorate. One of these projects may be a master's thesis or project. The second required research project is the dissertation.

### **Cognates (12 credits, minimum)**

Cognates are courses taken in other schools, departments or institutes within the University, which are selected for their relevance to the student's goals.

### **ADDITIONAL REQUIREMENTS**

Completion of one unit of Work Experience

Completion of a Research Experience

Completion of PEERRS training modules and certification

Attendance at the Center of Excellence Community of Scholars Seminar Series

### Appendix A-3 Proposed OHN-NP Master's Degree Course Requirements

<b>Nursing Core Courses(12 credits)</b>		
<b>Course</b>	<b>Title</b>	<b>Credits</b>
N532	Theoretical Base for Advanced Nursing Practice	3
N535	Strategies for Nursing & Health Care	3
N536	Utilization of Nursing Research in Advanced Practice	2
N603	Data Management, Analysis and Representation for Advanced Practice in Nursing	2
N699	Nursing Research/Thesis	2
ANP Courses (30 credits)		
N503*	Advanced Health Assessment for Advanced Practice Nurses	3
N537	Health Promotion and Risk Reduction Across the Lifespan	3
N543	Advanced Pathophysiology Across the Lifespan for Advanced Practice Nurses	3
N566*	Advanced Primary Care Nursing I	5
N666*	Advanced Primary Care Nursing II	4
N667*	Behavioral and Lifestyle Management in Primary Care	4
N668*	Advanced Primary Care Nursing of Adults and Families Within Complex Systems	4
P620	Pharmacotherapeutics For Primary Care I	2
P621	Pharmacotherapeutics For Primary Care II	2
Occupational Health and Safety Courses (14 credits)		
EHS550	Occupational & Environmental Health	3
EHS501	Occupational Diseases	2
EHS556	Occupational Ergonomics	2
EHS552	Occupational Safety	3
N572	Current and Emerging Issues in Occupational Health Nursing practice	2
N686	Interventions for Aggregates	2
Public Health Core Course (3 credits)		
EPI503	Strategies and Uses of Epidemiology	3
	<b>Total</b>	<b>59</b>

\*Includes a practicum or a laboratory

## **Appendix OSE--A: OSE Curriculum**

### **Masters Degree in Industrial and Operations Engineering Occupational Safety Engineering and Ergonomics (OSE) Option**

For more than 50 years, The University of Michigan's Department of Industrial and Operations Engineering (IOE) has offered graduate education in ergonomics. After the passage of the federal Occupational Safety and Health Act in 1970, an occupational safety option was created. Since then, approximately 250 Masters and 80 Ph.D. students have graduated specializing in Occupational Safety Engineering and Ergonomics (OSE).

The Masters degree is intended for students who hold a bachelor's degree in engineering or physical science. Most students can complete the OSE option in 10-16 months. Students have flexibility in selecting course work to match specific interests. A list of commonly-elected classes is available on the following pages. Those wishing to pursue a Ph.D. degree will find that the M.S. program provides excellent preparation.

A limited number of traineeships are available from the National Institute for Occupational Safety and Health (NIOSH) for U.S. Citizens and Permanent Residents who are interested in OSE professional and research careers. All NIOSH trainees are required to take the following core courses in safety, ergonomics, and public health.

#### **Safety/Occupational Health Core - 13 credits**

EHS 550: Introduction to Occ & Env Health (2 credits)  
EHS 600: Professional Perspectives in Environmental Health (2 credits, effective 2007-08)  
EHS 658: Physical Hazards (1 credit)  
IOE 438: Safety Management (2 credits)  
IOE 539: Safety Engineering Methods (3 credits)  
IOE 837: Occupational Health and Safety Engineering Seminar (1 credit)  
NUR 606: OHS Program Management (2 credits)

#### **Epidemiology and Statistics Core - 6 credits**

EPI 503: Strategies and Uses of Epidemiology (3 credits)  
IOE 465: Design of Experiments (3 credits)

#### **Seminars and Research - 4-5 credits**

IOE 836: Ergonomics Seminar (1 credit)  
IOE 590: Directed Research (3-4 credits)

All NIOSH trainees must complete a Master's research project (IOE 590) and must complete a minimum of 36 credit hours to receive financial assistance through the NIOSH grant.

Students who do not receive NIOSH funding can complete the M.S. degree with 30 credit hours and have more flexibility in course selection. Specific requirements for the IOE M.S. degree can be found at:

[http://ioe.engin.umich.edu/degrees/grad/gpai\\_docs/0804\\_MS\\_req\\_forbid.rtf](http://ioe.engin.umich.edu/degrees/grad/gpai_docs/0804_MS_req_forbid.rtf)

Many non-NIOSH students elect additional courses beyond the 30-credit minimum in order to enhance the breadth and depth of their education.

**TYPICAL SCHEDULE OF COURSES FOR NIOSH TRAINEES:**

**MASTER OF SCIENCE IN  
INDUSTRIAL AND OPERATIONS ENGINEERING  
(Occupational Safety Engineering and Ergonomics Option)**

**FALL TERM**

<u>Course</u>	<u>Credits</u>	<u>Instructor</u>
EHS 550 – Intro. to Occ. & Env. Health	2	Vincent
EHS 600 – Professional Perspectives	2	Jolliet
EIH 658 – Physical Hazards in the Work Environment	1	Zellers
IOE 539 – Occupational Safety Engineering	3	Keyserling
IOE 836 – Ergonomics Seminar	1	IOE Faculty
Electives	6-7	
<b>TOTAL CREDITS</b>	<b>5-16</b>	

**WINTER TERM**

<u>Course</u>	<u>Credits</u>	<u>Instructor</u>
EPI 503 – Strategies and Uses of Epidemiology	3	EPID Faculty
IOE 438 – Occupational Safety Management Frantz/Rhoades/Adams	2	
NUE 606 – OHS Program Management	2	OHN Faculty
IOE 465 – Design and Analysis of Experiments	3	IOE Faculty
IOE 837 – Occupational Health/Safety Seminar	1	IOE Faculty
Electives	5-6	
<b>TOTAL CREDITS</b>	<b>16-17</b>	

**SPRING HALF-TERM**

<u>Course</u>	<u>Credits</u>	<u>Instructor</u>
IOE 590/593 -- Directed Research/Professional Project	3	Selected by topic

**TOTAL PROGRAM CREDITS 34-36**

**Suggested and Elective Courses for  
Master of Science in Industrial and Operations Engineering  
(Occupational Safety Engineering and Ergonomics Option)**

Note: Departmental codes can be found at the bottom of the next page.

**Occupational Safety and Health**

CEE 533 –Advanced Construction Systems (3 cr.), Lecturer John Everett  
EHS 507 – Principals of Exposure Assessment (2 cr.), EHS Staff  
EHS 550 – Introduction to Occupational & Environmental Health (2 cr.), Prof. James Vincent  
EHS 581 – Principles of Radiological Health (1 cr.), Staff  
EHS 655 – Occupational Injury Prevention, (3 cr.), Prof. Ronald Maio  
EHS 658 – Physical Hazards in the Work Environment (1 cr.), Prof. Edward Zellers  
EPI 503 – Strategies and Uses of Epidemiology (3 cr.), EPID Staff  
EPI 651 – Epidemiology and Public Health Management of Disasters (2 cr.) Prof. Sienko Dean  
HBHE 667 – Bioterrorism: Community Preparation and Response (3 cr.), Prof. Greg Button  
IOE 438 – Occupational Safety Management (2 cr.) Adjunct Profs. P. Adams, P. Frantz , T. Rhoades  
IOE 539 – Safety Engineering Methods (3 cr.), Prof. Monroe Keyserling  
NAME 582 – Systems Reliability and Safety (3 cr.), Prof. Tassios Perakis  
NERS 484 – Radiological Health Engineering Fundamentals (4 cr.), Prof. Kimberlee Kearfott  
NUR 606 – Management for OEHS Professionals (2 cr.), Prof. Oiseang Hong

**Physical Ergonomics (Biomechanics, Anthropometry, Physiology, Work Measurement)**

IOE 463 – Measurement and Design of Work (3 cr.), Prof. Tom Armstrong  
IOE 491–Applied Physical Ergonomics (2 cr.), Prof. Tom Armstrong  
IOE 533 – Human Motor Behavior and Engineering Systems (3 cr.), Prof. Bernard Martin  
IOE 534 – Occupational Biomechanics (3 cr.), Prof. Bernard Martin  
IOE 567 – Work-related Musculoskeletal Disorders (3 cr.), Profs. Keyserling and Armstrong  
IOE 635 – Biomechanics Lab (2 cr.), Prof. Bernard Martin  
IOE 636 – Human Performance Lab (2 cr.), Prof. Bernard Martin  
IOE 691 – Lab in Biomech. & Work Phys. (2 cr.), Instructor Charles Woolley, Prof. Bernard Martin

**Cognitive Ergonomics (Human Factors Engineering, HCI):**

EECS 493 – User Interface Design and Analysis (3 cr.), Prof. David Kieras  
IOE 434 – Human Error & Complex System Failures (3 cr.), Prof. Nadine Sarter  
IOE 436 – Human Factors in Computer Systems (3 cr.), Adjunct Prof. Paul Green  
IOE 437 – Automotive Human Factors (3 cr.), Adjunct Prof. Paul Green  
IOE 491– Engineering Aesthetics (2 cr.), Prof. Yili Liu  
IOE 491 – Multi-modal Display Systems (3 cr.), Prof. Nadine Sarter  
IOE 491 – Intelligent Transportation (3 cr.), Prof. Barry Kantowitz  
IOE 536 – Cognitive Ergonomics (3 cr.), Prof. Nadine Sarter  
IOE 591 – Transportation Human Factors (2 cr.), Prof. Barry Kantowitz  
IOE 691 – Computational Cognitive Ergonomics (3 cr.), Prof. Yili Liu  
Psych 449 – Decision Processes (3 cr.), Staff  
Psych 689 – Culture and Cognition (2 cr.), Staff  
Psych 643/EECS 643 – Theory of Neural Computation (2-4 cr.), Staff  
Psych 948 – Seminar in Psychological Processes: Learning, Thinking, and Problem Solving (3 cr.)

SI 649 – Information Visualization (3 cr.), Staff  
SI 682 – User-Interface Design (3 cr.), Staff  
SI 688 – Fundamentals of Human Behavior (3 cr.), Staff  
SI 689 – Computer-Supported Cooperative Work (3 cr.), Staff

### **Engineering Breadth**

AERO 729 – Spec. Top. in Gas Dynamics: Explosions, Explosives (3 cr.), Prof. Wm. Kauffman  
BME 456 – Tissue Biomechanics (3 cr.), Prof. Scott Hollister  
BME 458 – Biomedical Instrumentation and Design (3 cr.), Profs. Anderson or Kipke  
IOE 425 – Manufacturing Strategies (2 cr.), IOE Staff  
IOE 432 – Instrumentation (3 cr.), Instructor Charles Woolley  
IOE 465 – Design and Analysis of Industrial Experiments (3 cr.), IOE Staff  
IOE 466 – Statistical Quality Control (3 cr.), IOE Staff  
IOE 562 – Reliability (3 cr.), Prof. Vijay Nair  
MEAM 452– Design for Manufacturability (3 cr.) MEAM Staff  
MEAM 589 – Failure Analysis Case Studies (3cr.) MEAM Staff

### **Management/Legal/Finance Breadth**

IOE 421 – Work Organizations (3 cr.), Prof. Jeffrey Liker  
IOE 452 – Corporate Finance (3 cr.), Prof. Jussi Keppo  
IOE 522 – Theories of Administration (3 cr.), Prof. Jeffrey Liker  
IOE 551 – Benchmarking, Productivity Analysis, and Performance Meas. (3 cr.), Prof. Larry Seiford

Comment: In addition to the above, students may elect from an extensive list of courses offered by the Ross School of Business

### **Projects, Research, and Seminars:**

EHS 659 – Injury Prevention Seminar (1 cr.), EHS Faculty  
IOE 590 – Directed Research (2-4 cr.), IOE Faculty  
IOE 593 –Ergonomics Professional Project (2-4 cr.), IOE Faculty  
IOE 836 – Seminar in Human Performance (1 cr.), IOE Faculty  
IOE 837 – Seminar in Occ. Health and Safety Engineering (1 cr.), IOE Faculty

Department Codes: BME – Biomedical Engineering  
CEE – Civil and Environmental Engineering  
EECS -- Electrical Engineering and Computer Science  
EHS – Environmental Health Science (Public Health)  
EPI – Epidemiology (Public Health)  
IOE – Industrial and Operations Engineering  
MEAM – Mechanical Engineering and Applied Mechanics  
NAME– Naval Architecture and Marine Engineering  
NERS – Nuclear Engineering and Radiological Science  
NUR – Nursing  
PSYCH – Psychology  
SI – School of Information

APPENDIX OE-A

**OCCUPATIONAL EPIDEMIOLOGY SAMPLE CURRICULUM AND COURSE DESCRIPTIONS**

**MASTER'S (MPH) CURRICULUM IN OCCUPATIONAL EPIDEMIOLOGY**

<b>Course Number</b>	<b>Course Title</b>	<b>Credit Hours</b>
<b>Year 1, Fall Term</b>		
BIOS 553	Applied Biostatistics	4
EHS 506	Principles of Toxicology	2
EHS 507	Principles of Exposure Assessment	2
EPID 600	Introduction to Epidemiology	4
	Elective	3
	<b>Sub-Total</b>	<b>15</b>
<b>Year 1, Winter Term</b>		
BIOS 510	Statistical Computer Program Packages	3
BIOS 523	Biostatistical Analysis for Health Related Studies	3
EHS 501	Occupational and Environmental Disease	2
EHS 508	Principles of Risk Assessment	2
EPID 601	Principles and Methods of Epidemiology	4
EPID 655	Field Studies in Epidemiology	2
	<b>Sub-Total</b>	<b>16</b>
<b>Year 2, Fall Term</b>		
EHS 600	Professional Perspectives in Environmental Health	2
BIOS 560	Statistical Methods in Epidemiology	4
EPID 656	Applied Epidemiologic Data Analysis	3
	Electives	5
	<b>Sub-Total</b>	<b>14</b>
<b>Year 2, Winter Term</b>		
EHS 608	Environmental Epidemiology	2
HBHE 670	The Stress Process (SPH-MPH Req)	3
HMP 610	Cost-Effectiveness and Cost-Benefit Analysis in Health (SPH-MPH Req)	3
EHS 668	Topics in Environmental Health Sciences Seminar	1
EHS 670	Applications in Environmental Epidemiology	3
	Elective	3
	<b>Sub-Total</b>	<b>15</b>
	<b>TOTAL</b>	<b>60</b>

**PH.D. COURSE REQUIREMENTS IN OCCUPATIONAL EPIDEMIOLOGY  
DOCTOR OF PHILOSOPHY (Ph.D.)**

**Departmental Course Requirements**

*Select one of the following*

- BIOSTAT 503 (4) Introduction to Biostatistics
- BIOSTAT 553 (4) Applied Biostatistics
- STAT 400 (4) Applied Statistical Methods

*Select one of the following*

- EPID 503 (3) Strategies and Uses of Epidemiology
- EPID 600 (3) Introduction to Epidemiology
- EPID 601 (4) Principles and Methods in Epidemiology

*Select two of the following:*

- BIOSTAT 513 (3) Application of Regression Analysis to Health Studies
- BIOSTAT 523 (3) Biostatistical Analysis for Health-Related Studies
- Statistics 401 (3) Applied Statistical Methods II

*Statistics or Biostatistics course (determined with advisor and approval of doctoral committee)*

Cognate Course – One 2-3 credit hour course outside the Department of Environmental Health Sciences (to be determined by advisor with approval of doctoral committee)

- EHS 688 (1) Topics in Environmental Health Sciences<sup>1</sup>
- EHS 899 (≤6) Advanced Research (2 separate rotations required)<sup>2</sup>
- EHS 869 (1) Doctoral Seminar in Environmental Health Sciences<sup>3</sup>

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<sup>1</sup>EHS 688 is a departmental seminar that spans the first 2 terms. Students are expected to attend seminars throughout their doctoral program but they do not have to officially register.

<sup>2</sup>EHS 899 - Students complete two separate rotations with different faculty for a minimum of 1 credit each time

<sup>3</sup>EHS 869 is a doctoral seminar that students register for until they have passed their Preliminary Exam. Prior to the Prelim exam, they will present a formal seminar in this class

**Additional Course Requirements**

*Select one of the followings*

- EHS 501 (2) Occupational Diseases
- EHS 506 (2) Principles of Toxicology
- EHS 507 (2) Principles of Exposure Assessment
- EHS 508 (2) Principles of Risk Assessment

*Select one of the following:*

EHS 550 (3) Principles of Occupational and Environmental Health  
EHS 570 (3) Water Quality  
EHS 572 (2) Environmental Impact Assessment  
EHS 574 (3) Environmental Chemistry  
EHS 576 (3) Microbiology in Environmental Health  
*500-level EHS course (determined with mentor and approval of doctoral committee)*

*Select 3 of the following courses (or any 600-level course in EHS added subsequently):*

EHS 608 (3) Environmental Epidemiology  
EHS 612 (3) Biochemical and Molecular Toxicology  
EHS 625 (2) Environment & the Immune Response  
EHS 630 (4) Principles of Nutritional Sciences  
EHS 631 (4) Advanced Nutritional Sciences  
EHS 643 (3) Food & Nutrition Policy & Programs  
EHS 645 (3) Nutritional Education: Theory & Practice  
EHS 652 (3) Evaluation of Chemical Hazards  
EHS 653 (3) Environmental Sampling and Analysis Lab  
EHS 654 (3) Control of Exposures to Airborne Contaminants  
EHS 657 (3) Advanced Exposure Assessment  
EHS 672 (3) Life cycle assessment: Human health and environmental impacts  
EHS 680 (3) Environ Management Hazardous Substances

**Qualifying Examination** – Predoctoral students normally take the EHS Qualifying Examination following their first year in the program, after completion of the required didactic coursework.

**Predoctoral Examination** – Predoctoral students who have passed the Qualifying Examination must pass the Preliminary Examination in order to advance to candidacy. The Preliminary Examination is normally completed during the third year in the program.

**APPENDIX HSAT-A**  
**Curricula and Sample Schedule for HSAT-MPH**

Course Number	Course Title	Credit Hrs
<b>Year 1. Fall Term</b> (September – December)		
BIOSTAT 503	Introduction to Biostatistics <i>(Alternatively, students may complete BIOSTAT 553 (4) Applied Biostatistics, or STAT 400 (4) Applied Statistical Methods)</i>	4
EHS 506	Principles of Toxicology	2
EHS 507	Principles of Exposure Assessment	2
EHS 550	Principles of Industrial Hygiene	2
EHS 652	Evaluation of Chemical Hazards	3
EHS 574	Environmental Chemistry	3
EHS 688	Topics in Environmental Health Sciences	1
<b>Sub-Total</b>		<b>17</b>
<b>Year 1. Winter Term</b> (January – April)		
BIOSTAT 513	Application of Regression Analysis to Public Health Studies	3
EHS 501	Occupational and Environmental Disease	2
EHS 653	Chemical Exposure and Measurement Laboratory	3
EHS 654	Control of Exposure to Airborne Contaminants	3
EHS 668	Professional Seminars in Occupational Health	1
EPID 503	Strategies and Uses in Epidemiology	3
HMP 617	Health Care Organization	3
<b>Sub-Total</b>		<b>17</b>
<b>Year 1. Spring/Summer</b> (May – August)		
	Field Experience	NA
	HAZWOPER Training <i>(often completed during spring break in February/March, year 1)</i>	NA
<b>Year 2. Fall Term</b> (September – December)		
EHS 570	Water Quality Management	3
EHS 572	Environmental Impact Assessment	2
EHS 600	Professional Perspectives in Environmental Health	2
EHS 658	Physical Hazards	1
EHS 757	Occupational Health Aspects of Industrial Processes	2
IOE 539	Occupational Safety Engineering	3
HBEHED 667	Bioterrorism: Community Preparation and Response <i>Alternatives: HBHE 600 (3) Psychosocial Factors in Health Related Behavior; HBHE 615 (3) Mass Media, Public Health Practice and Intervention; HBHE 622 (3) Program Evaluation in Health Education; HBHE 631 (3) Budget Practices in Health Education Programs; HBHE 640 (3) Community Organization of Health Education; HBHE 690 (3) Environmental Health Education; HBHE 692 (3) Women's Health &amp; Reproductive Health</i>	3
<b>Sub-Total</b>		<b>16</b>
<b>Year 2. Winter Term</b> (January – April)		
NURS 606	Management for Occupational & Environmental Health and Safety Professionals	2
EHS 508	Principles of Risk Assessment	2
EHS 556	Occupational Ergonomics <i>(Alternative: IOE 755 (3) Work Related Upper Limb Disorders)</i>	2
EHS 581	Principles of Radiological Health	1
EHS 668	Occupational Health Seminar	1
EHS 680	Environmental Management of Hazardous Substances	3
NRE 595	Risk-Benefit Analysis <i>(Alternatives: ENSCEN 686 (2) Environmental Sustainability; NRE 537 (3) Industrial Ecology.)</i>	3
<b>Sub-Total</b>		<b>14</b>
<b>TOTAL</b>		<b>64</b>



ERC Applicant Institution: University of Michigan  
 Program Director:

**Appendix CE-1**  
**CE Course Offerings by Program Area**  
**Previous Budget Period: July 1, 2006 to June 30, 2007**

**Program Area: Industrial Hygiene**

Course/Seminar Title <sup>1</sup>	Program Area	Total Trainees	Length of Course	Total Pers Days	# Trainees by Profession					# Trainees by Employer						
					MD	NURS	HYG	SAFETY	OTHER	Private Industry	Fed Gov	State Gov	Local Gov	Foreign Country	Academic	Other
Summer Session on Epidemiology (25%) **	IH	62	4.7	291.4	20	5	6	7	24	20	4	5	4	4	21	4
Industrial Hygiene Comprehensive Review (HI, Aug)	IH	18	5	90	0	0	18	0	0	5	11	0	0	0	2	0
Industrial Hygiene Comprehensive Review (Sept)	IH	41	4.5	184.5	0	0	41	0	0	35	4	1	0	0	1	0
Cook Industrial Hygiene Discussional	IH	27	1.5	40.5	0	0	27	0	0	23	0	0	2	0	2	0
Occupational Biomechanics (25%)**	IH	30	1.5	45	1	0	1	8	20	12	0	0	1	1	16	0
Preventing Musculoskeletal Disorders (25%)**	IH	22	2	44	2	1	4	3	12	10	1	3	1	0	6	1
Occupational Ergonomics (25%)**	IH	8	4	32	0	0	1	4	3	7	0	0	0	0	1	0
Ergonomic Job Analysis (25%**)	IH	5	1.5	7.5	0	0	2	2	1	5	0	0	0	0	0	0
Accommodating Physical Impairments (25%**)	IH	3	0.5	1.5	0	0	1	0	2	3	0	0	0	0	0	0
Industrial Hygiene Comprehensive Review (Mar)	IH	50	4.5	225	0	0	50	0	0	43	3	1	0	0	3	0

NORA Symposium at the MSC (25%**)	IH	32	0.5	16	3	5	8	16	0	23	0	5	0	0	1	3
Ergonomics Principles (25%**)	IH	8	2	16	0	0	1	4	3	7	0	1	0	0	0	0
<b>Subtotal [IH]</b>	<b>IH</b>	<b>306</b>		<b>993</b>	<b>26</b>	<b>11</b>	<b>160</b>	<b>44</b>	<b>65</b>	<b>193</b>	<b>23</b>	<b>16</b>	<b>8</b>	<b>5</b>	<b>53</b>	<b>8</b>

ERC Applicant Institution: University of Michigan  
Program Director:

**Appendix CE-1**  
**CE Course Offerings by Program Area**  
**Previous Budget Period: July 1, 2006 to June 30, 2007**

**Program Area: Occupational Safety**

Course/Seminar Title <sup>1</sup>	Program Area	Total Trainees	Length of Course	Total Pers Days	# Trainees by Profession					# Trainees by Employer						
					MD	NURS	HYG	SAFETY	OTHER	Private Industry	Fed Gov	State Gov	Local Gov	Foreign Country	Academic	Other
Summer Session on Epidemiology (25%) **	OS	62	4.7	291.4	21	5	6	7	23	19	5	6	4	4	20	4
Biomechanical job Analysis, 3DSSPP	OS	10	0.5	5	0	0	0	5	5	10	0	0	0	0	0	0
Occupational Biomechanics (25%**)	OS	30	1.5	45	2	0	1	7	20	13	0	0	0	1	16	0
Preventing Musculoskeletal Disorders (25%**)	OS	22	2	44	2	1	4	3	12	10	0	4	1	0	6	1
Occupational Ergonomics (25%**)	OS	7	4	28	0	0	1	3	3	7	0	0	0	0	0	0
Ergonomic Job Analysis (25%**)	OS	5	1.5	7.5	1	0	2	1	1	4	0	0	1	0	0	0
Accommodating Physical Impairments (25%**)	OS	3	0.5	1.5	0	0	0	1	2	3	0	0	0	0	0	0
NORA Symposium at the MSC (25%**)	OS	32	0.5	16	3	5	8	16	0	22	0	5	0	0	2	3
Ergonomics Principles (25%**)	OS	7	2	14	0	0	1	3	3	7	0	0	0	0	0	0
Using the 3DSSPP	OS	17	1.5	25.5	0	2	1	11	3	17	0	0	0	0	0	0
<b>Subtotal [OS]</b>	<b>OS</b>	<b>195</b>		<b>478</b>	<b>29</b>	<b>13</b>	<b>24</b>	<b>57</b>	<b>72</b>	<b>112</b>	<b>5</b>	<b>15</b>	<b>6</b>	<b>5</b>	<b>44</b>	<b>8</b>

ERC Applicant Institution: University of Michigan

Program Director:

**Appendix CE-1**  
**CE Course Offerings by Program Area**  
**Previous Budget Period: July 1, 2006 to June 30, 2007**  
**Program Area: Occupational Health Nursing**

Course/Seminar Title <sup>1</sup>	Program Area	Total Trainees	Length of Course	Total Pers Days	# Trainees by Profession					# Trainees by Employer						
					MD	NURS	HYG	SAFETY	OTHER	Private Industry	Fed Gov	State Gov	Local Gov	Foreign Country	Academic	Other
Summer Session on Epidemiology (25%) **	OHN	62	4.7	291.4	20	5	6	7	24	19	5	6	4	5	20	3
Physical Assessment for the OHN	OHN	18	4	72	0	18	0	0	0	18	0	0	0	0	0	0
Occupational Biomechanics (25%)**	OHN	30	1.5	45	1	0	1	8	20	12	0	0	1	1	16	0
Preventing Musculoskeletal Disorders (25%)**	OHN	22	2	44	2	1	4	4	11	10	1	3	2	0	5	1
Occupational Ergonomics (25%)**	OHN	7	4	28	0	0	1	3	3	7	0	0	0	0	0	0
Ergonomic Job Analysis (25%**)	OHN	5	1.5	7.5	1	1	1	2	0	5	0	0	0	0	0	0
Accommodating Physical Impairments (25%**)	OHN	2	0.5	1	0	0	0	0	2	2	0	0	0	0	0	0
Occupational Health and Nursing Cert. Review	OHN	15	3	45	0	15	0	0	0	15	0	0	0	0	0	0
Safety Series AAOHN Module 1	OHN	59	0.5	29.5	0	59	0	0	0	59	0	0	0	0	0	0
Safety Series AAOHN Module 2	OHN	46	0.5	23	0	46	0	0	0	46	0	0	0	0	0	0
Safety Series AAOHN Module 3	OHN	46	0.5	23	0	46	0	0	0	46	0	0	0	0	0	0
Safety Series AAOHN Module 4	OHN	47	0.5	23.5	0	47	0	0	0	47	0	0	0	0	0	0
NORA Symposium at the MSC (25%**)	OHN	33	0.5	16.5	3	5	8	17	0	23	0	5	0	0	2	3

Ergonomics Principles (25%**)	OHN	7	2	14	0	0	1	3	3	7	0	0	0	0	0	0
<b>Subtotal [OHN]</b>	<b>OHN</b>	<b>399</b>		<b>663</b>	<b>27</b>	<b>243</b>	<b>22</b>	<b>44</b>	<b>63</b>	<b>316</b>	<b>6</b>	<b>14</b>	<b>7</b>	<b>6</b>	<b>43</b>	<b>7</b>

ERC Applicant Institution: University of Michigan  
Program Director:

**Appendix CE-1**  
**CE Course Offerings by Program Area**  
**Previous Budget Period: July 1, 2006 to June 30, 2007**

**Program Area: Occupational Medicine**

Course/Seminar Title <sup>1</sup>	Program Area	Total Trainees	Length of Course	Total Pers Days	# Trainees by Profession					# Trainees by Employer						
					MD	NURS	HYG	SAFETY	OTHER	Private Industry	Fed Gov	State Gov	Local Gov	Foreign Country	Academic	Other
Summer Session on Epidemiology (25%) **	OM	62	4.7	291.4	21	5	5	7	24	19	5	5	4	5	20	4
Occupational Biomechanics (25%)**	OM	30	1.5	45	2	0	1	7	20	13	0	0	0	1	16	0
Preventing Musculoskeletal Disorders (25%)**	OM	21	2	42	1	0	5	3	12	10	1	3	1	0	5	1
Occupational Ergonomics (25%)**	OM	7	4	28	1	0	0	4	2	6	0	0	1	0	0	0
Ergonomic Job Analysis (25%)**	OM	5	1.5	7.5	1	0	1	2	1	4	0	1	0	0	0	0
Accommodating Physical Impairments (25%)**	OM	2	0.5	1	0	0	0	0	2	2	0	0	0	0	0	0
NORA Symposium at the MSC (25%)**	OM	33	0.5	16.5	3	5	9	16	0	23	0	5	0	0	2	3
Ergonomics Principles (25%**)	OM	7	2	14	0	0	0	4	3	6	0	0	1	0	0	0
<b>Subtotal [OM]</b>	<b>OM</b>	<b>167</b>		<b>445</b>	<b>29</b>	<b>10</b>	<b>21</b>	<b>43</b>	<b>64</b>	<b>83</b>	<b>6</b>	<b>14</b>	<b>7</b>	<b>6</b>	<b>43</b>	<b>8</b>

<b>Grand Total</b>		<b>1,067</b>		<b>2,580</b>	<b>111</b>	<b>277</b>	<b>227</b>	<b>188</b>	<b>264</b>	<b>704</b>	<b>40</b>	<b>59</b>	<b>28</b>	<b>22</b>	<b>183</b>	<b>31</b>
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**\*\*If course is attributable to multiple program areas, the fraction of course attributable to the program area is shown in parentheses. *No single program is counted more than a total of 1.0.***

ERC Applicant Institution: University of Michigan  
 Program Director:

**Appendix CE-2**  
**Summary of CE Course Offerings by Program Area**  
**Previous Budget Period: July 1, 2006 to June 30, 2007**

Course/Seminar Title <sup>1</sup>	Program Area	Total Trainees	Total # of Courses	Total Pers Days	# Trainees by Profession					# Trainees by Employer						
					MD	NURS	HYG	SAFETY	OTHER	Private Industry	Fed Gov	State Gov	Local Gov	Foreign Country	Academic	Other
Subtotal IH	IH	306	6	993	26	11	160	44	65	193	23	16	8	5	53	8
Subtotal OHN	OHN	399	8	663.4	27	243	22	44	63	316	6	14	7	6	43	7
Subtotal OMR	OMR	167	2	445.4	29	10	21	43	64	83	6	14	7	6	43	8
Subtotal OS	OS	195	4	478	29	13	24	57	72	112	5	15	6	5	44	8
<b>GRAND TOTALS (All Program Areas)</b>		<b>1,067</b>	<b>20</b>	<b>2,580</b>	<b>111</b>	<b>277</b>	<b>227</b>	<b>188</b>	<b>264</b>	<b>704</b>	<b>40</b>	<b>59</b>	<b>28</b>	<b>22</b>	<b>183</b>	<b>31</b>

## Appendix CE-3

### Continuing Education Program Descriptions for 2006-2007 **Descriptive Summary of Continuing Education Courses Offered July 2006 through June 2007**

Program: July 9-28, 2006  
41<sup>st</sup> Annual Graduate Summer Session on Epidemiology  
Ann Arbor, MI

Attendees: 248  
Person days of training: 1165.6

#### Program Description:

The summer program offers instruction in the principles, methods and applications of epidemiology. Distinguished faculty from academic centers and governmental agencies throughout the United States and other countries will be responsible for introductory and advanced courses in epidemiology, biostatistics and data management. Curriculum options include one-week, three-week and weekend courses. Special evening lectures by guest speakers, and weekly social events, complement the classroom sessions. Following is a list of courses that were offered:

- Fundamentals of Biostatistics (3 week course)
- Principles and Applications of Epi Info
- Applied Computing in Epidemiologic Research
- Introduction to SAS
- Topics in Infectious Diseases
- Epidemiology and Health Policy
- Epidemiology of Injury and Violence
- Clinical Epidemiology and Evidence-Based Decision Making
- Design and Conduct of Clinical Trials
- Analysis of Clinical Trials
- Genetics in Epidemiology
- Community Based Interventions for Behavioral & Social Change
- CVD Epidemiology: Foundation for Public Health Policy & Practice
- Cancer Epidemiology: Etiologic Evidence/Assigning Priorities
- Social Epidemiology
- Analysis of Longitudinal Data from Epidemiologic Studies
- Methods in Community-Based Participatory Research for Health
- Public Health Surveillance
- Bias and Its Control in Epidemiologic Research
- Fundamentals of Epidemiology (3 week course)
- Epidemiology in Public Health Practice (3 week course)
- Pharmacoepidemiology and Risk Management
- Fertility and Pregnancy—An Epidemiologic Perspective
- Introduction to Logistic and Poisson Models
- Applied Linear Regression
- Survival Analysis Applied to Epidemiologic and Medical Data
- Successful Scientific Writing
- Ethics, Law, and Epidemiology
- Introduction to Systematic Reviews and Meta-Analysis
- Complex Sample Survey Data Analysis with SUDAAN
- Probability Sampling Techniques in Epidemiology
- Global Health Issues, Crises, and Solutions
- Geographic Information Systems for Epidemiology
- Fundamentals of Epidemiology (3 week course)

Occupation Category					Employer Category							
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH	
82	20	23	28	95	77	19	22	16	18	81	15	

Program: August 14-18, 2006  
Comprehensive Industrial Hygiene Review  
Honolulu, HI

Attendees: 18  
Person days of training: 90

Program Description:

This 5 day course is an intensive, high-level review of a wide range of industrial hygiene topics to help those preparing for certification exams. It provides attendees with comprehensive and contemporary information delivered by University of Michigan Emeritus Professor Steve Levine. The course benefits individuals needing to broaden or refresh their industrial hygiene knowledge base and will assist them in focusing their efforts to pursue professional certification.

Occupation Category					Employer Category							
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH	
0	0	18	0	0	5	11	0	0	0	2	0	

Program: September 25-29, 2006  
Comprehensive Industrial Hygiene Review  
Ann Arbor, MI

Attendees: 41  
Person days of training: 184.5

Program Description:

This 4.5 day course is an intensive, high-level review of a wide range of industrial hygiene topics to help those preparing for certification exams. It provides attendees with comprehensive and contemporary information delivered by more than a dozen experts from the University of Michigan and from the private sector. The course benefits individuals needing to broaden or refresh their industrial hygiene knowledge base and will assist them in focusing their efforts to pursue professional certification.

Occupation Category					Employer Category							
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH	
0	0	41	0	0	35	4	1	0	0	1	0	

Program: October 22, 2006  
Biomechanical Job Analysis Using the University of Michigan Three-Dimensional Static Strength Prediction Program (3DSSPP)

Alberta, Canada

Attendees: 10  
 Person days of training: 5

Program Description:

This half-day workshop provided an overview of the 3DSSPP including demonstrations and hands-on practice. The 3DSSPP is an analysis tool used to predict the capabilities of a population to safely perform manual work tasks. The stress on the body and the strength requirements of a given task are estimated based upon workplace analysis or design information. This workshop was presented in conjunction with the Association of Canadian Ergonomists.

Occupation Category					Employer Category							
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH	
0	0	0	5	5	0	0	0	0	10	0	0	

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Program: October 30 – November 2, 2006  
Physical Assessment for the Occupational Health Nurse: Updates, Application and Use in Occupational Health Settings  
 Dearborn, MI

Attendees: 18  
 Person days of training: 72

Program Description:

This 4-day course provides lectures and hands-on workshop activities to provide the occupational health nurse with knowledge needed to assess the physical health status of individuals specific to a variety of occupational health settings. Many body organs and systems are covered. Information related to collecting a medical history, documenting findings and adherence to HIPAA regulations is also included.

Occupation Category					Employer Category							
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH	
0	18	0	0	0	18	0	0	0	0	0	0	

Program: November 2-3, 2006  
43<sup>rd</sup> Annual Warren Cook Discussional on Industrial Hygiene  
 Ann Arbor, MI

Attendees: 27

Person days of training: 40.5

Program Description:

This program consists of one and one half days of discussion by prominent leaders in the field of Industrial Hygiene. Discussion sessions are directed by University of Michigan faculty. The Discussional offers a unique opportunity to share information about issues of contemporary interest to industrial hygienists.

Occupation Category					Employer Category							
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH	
0	0	27	0	0	23	0	0	2	0	2	0	

Program: November 16-17, 2006  
Occupational Biomechanics Symposium: Celebrating 35 Years of  
Progress and Looking Toward the Future  
 Ann Arbor, MI

Attendees: 120

Person days of training: 180

Program Description:

Occupational biomechanics has become an important tool for design of work equipment and activities. Contemporary biomechanical models can be used to objectively identify work activities that exceed workers' reach and strength capability or present high risk of injury. This symposium brought together leading researchers to discuss: contemporary models; studies that support model use and development; and the impact models have on contemporary design of jobs in manufacturing and other work settings.

Occupation Category					Employer Category							
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH	
6	0	4	30	80	50	0	0	2	4	64	0	

Program: December 14-15, 2006  
Ergonomic Interventions and Research: Preventing Workplace  
Musculoskeletal Disorders  
 Berkeley, CA

Attendees: 87  
 Person days of training: 174

Program Description:

Musculoskeletal disorders continue to be costly in terms of worker suffering and employer expense. This program gathered researchers and practicing ergonomists from a cross section of industries to describe how ergonomics principles can be applied to evaluate and design workplaces and tasks to prevent these disorders and their associated disabilities and costs. Examples of successful ergonomic interventions and programs in several industries were included.

Occupation Category					Employer Category							
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH	
7	3	17	13	47	40	3	13	5	0	22	4	

Program: February 26 – March 1, 2007  
Occupational Ergonomics: Work Evaluation and Prevention of Upper  
Limb and Back Disorders  
 Los Angeles, CA

Attendees: 29  
 Person days of training: 116

Program Description:

Manual labor continues to be one of our most valuable industrial resources despite strides in production automation. More than ever, it is important that jobs and equipment be designed to enable workers to achieve their full potential while preventing pain and injury. This course provides comprehensive coverage of ergonomic issues and principles associated with manual work and workplace musculoskeletal disorders. Leading ergonomic practitioners and educators provide lectures, case studies, video depictions of workplaces and discussion sessions. The focus is on ergonomic principles and concepts so that attendees can apply this information to their own work environments. Topics include: biomechanics; risk factors of upper extremity and low back disorders; fatigue; job evaluation techniques; common worker medical issues; and industrial ergonomics programs and justification to management.

Occupation Category					Employer Category							
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH	
1	0	3	14	11	27	0	0	1	0	1	0	

Program: March 2-3, 2007  
Ergonomic Job Analysis  
 Los Angeles, CA

Attendees: 20  
 Person days of training: 30

Program Description:

Ergonomic analysis of jobs is an essential part of a comprehensive program for controlling work-related musculoskeletal disorders such as low back pain and upper extremity repetitive trauma. This program uses lectures and demonstrations to develop practical job analysis skills. Students participate in analyses and discussion of videotaped jobs selected from a variety of industries and occupations. Case studies and discussions emphasize the identification and evaluation of ergonomic stresses and the development of alternative solutions to workplace problems. This course is intended for individuals who already have a basic knowledge of occupational ergonomics.

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
3	1	6	7	3	18	0	1	1	0	0	0

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Program: March 12, 2007  
Developing Accommodations for Employees with Physical Impairments  
 Dallas, TX

Attendees: 10  
 Person days of training: 5

Program Description:

This half-day program is planned as a pre-conference workshop at the Applied Ergonomics Conference. Workplace parameters often prevent people with musculoskeletal disorders and other physical impairments from performing required duties, of which they are otherwise capable. This program will explore the issues associated with placement of such workers. Using ergonomic principles for workplace design and accommodations, a fundamental framework for determining job requirements and worker capabilities that develops appropriate workplace parameters to enable worker participation will be presented.

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
0	0	1	1	8	10	0	0	0	0	0	0

Program: March 26-30, 2007  
Comprehensive Industrial Hygiene Review  
 Ann Arbor, MI

Attendees: 50  
 Person days of training: 225

Program Description:

This 4.5 day course is an intensive, high-level review of a wide range of industrial hygiene topics to help those preparing for certification exams. It provides attendees with comprehensive and contemporary information delivered by more than a dozen experts from the University of Michigan and from the private sector. The course benefits individuals needing to broaden or refresh their industrial hygiene knowledge base and will assist them in focusing their efforts to pursue professional certification.

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
0	0	50	0	0	43	3	1	0	0	3	0

Program: March 27-29, 2007  
Occupational Health and Safety Principles and Nursing Certification Review  
 Ann Arbor, MI

Attendees: 15  
 Person days of training: 45

Program Description:

This 3-day course provides an intensive overview of the principles of occupational health nursing practice. It is designed for nurses managing occupational health and safety programs, services and staff and performing OHN clinical functions such as counseling and client advocacy. This program will be of particular interest to nurses preparing for the COHN and COHN-S examinations.

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
0	15	0	0	0	15	0	0	0	0	0	0

Programs: April 14-15, 2007  
Principles of Safety Management & Voluntary OSHA Compliance at the AAOHN 2007 Symposium and Expo  
 Orlando, FL

Program Description: (Four half-day programs are presented. Separate registration is required.)

**Module 1: Fundamental OSHA Hazard Communication**

Attendees: 59  
 Person days of training: 29.5

The roles of OHNs are being expanded to include greater responsibility for company safety programs and OSHA compliance. This workshop introduces OSHA standards and the compliance inspection process. The components of an effective safety and health program are discussed, and an update of OSHA's recordkeeping standard is provided. The essential components of an effective and OSHA-compliant Hazard Communication program are discussed.

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
0	59	0	0	0	59	0	0	0	0	0	0

**Module 2: Selected Outcome & Performance Standards**

Attendees: 46  
 Person days of training: 23

Slips, trips and falls are the major cause of general industry accidents and incidents. This workshop will provide an overview of OSHA standards pertaining to walking-working surfaces, exit routes, emergency response and fire prevention plans. Information will also be provided on how to conduct a hazard assessment to prescribe appropriate types of personal protective equipment (PPE).

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
0	46	0	0	0	46	0	0	0	0	0	0

**Module 3: Electrical & Confined Space Hazard Control**

Attendees: 46  
 Person days of training: 23

OSHA statistical data confirm the hazards of worker death or serious injury from electrical current; failure to properly perform lock out/tag out (LOTO); and entry into confined spaces with hazardous atmospheres. This workshop will examine hazardous conditions involving energized equipment and confined space environments. Participants will be provided with examples of written program tools, which can be adapted for individual work settings.

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
0	46	0	0	0	46	0	0	0	0	0	0

**Module 4: Machine Guarding & Evaluation of Safety and Health Programs**

Attendees: 47  
 Person days of training: 23.5

Machine safeguarding is the primary way to control amputation and crush hazards from mechanical components of stationary machinery. This session will identify hazardous motions, safeguarding principles and options for a variety of common workplace machines. In addition, attendees will participate in hazard identification using tools such as Job Hazard Analysis and accident investigation. Risk management concepts will then be utilized to assess the identified hazards.

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
0	47	0	0	0	47	0	0	0	0	0	0

Program: April 17, 2007  
NORA Symposium at the Michigan Safety Conference: "Mold Research and Practice: The Realities and the Myths"  
 Grand Rapids, MI

Attendees: 130  
 Person days of training: 65

Program Description:

This half-day symposium explored the complex issues surrounding mold contamination in residential and commercial structures. This session provided an understanding of the types of mold that are commonly encountered indoors, their ecology, and how to inhibit their growth. Some aspects of health effects are highly controversial- information on what is known and what is myth was presented. Techniques for remediation and the assessment of whether remediation has been performed properly was discussed. This symposium was delivered at the 2007 Michigan Safety Conference.

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
12	20	33	65	0	91	0	20	0	0	7	12

Program: May 8-9, 2007  
Ergonomics Principles for Workplace Assessment and Design  
 Ann Arbor, MI

Attendees: 29  
 Person days of training: 58

Program Description:

Ergonomics is recognized as one of the most important factors in the occupational environment today affecting employee injury and illness. Attention to ergonomic workplace design is important to prevent musculoskeletal disorders and to promote productive workplaces. Many companies, as well as state and federal regulatory agencies, view ergonomics as a means to reduce injuries and illnesses such as cumulative trauma disorders of the upper extremities (tendonitis, carpal tunnel syndrome, etc.) and low back disorders. This two day program introduces the audience to contemporary concepts of occupational ergonomics. The program format is lectures, interspersed with problem solving examples and case studies.

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
0	0	3	14	12	27	0	1	1	0	0	0

Program: June 19-20, 2007  
Using the 3D Static Strength Prediction Program  
 Ann Arbor, MI

Attendees: 17  
 Person days of training: 25.5

Program Description:

Manual materials handling activities present significant ergonomic challenges for workers and are associated with many musculoskeletal disorders such as strains, sprains and low back pain. The 3D Static Strength Prediction Program™ (3D SSPP™) is an ergonomics job analysis and design tool developed by the University of Michigan Center for Ergonomics to quantify biomechanical requirements during manual materials handling tasks. This 1-1/2 day workshop is devoted to training individuals with an ergonomics background how to use the computer software and interpret its output. This workshop will include lectures with numerous reinforcing hands-on computer workshop activities supervised by course instructors. Biomechanics principles will be reviewed, but this should be refresher information for attendees. Enrollment will be limited to ensure that all attendees will have access to a computer throughout the course.

Occupation Category					Employer Category						
MD	RN	IH	SAF	OTH	PRI	FED	STA	LOC	FOR	ACAD	OTH
0	2	1	11	3	17	0	0	0	0	0	0

## Appendix B. Publications

### **APPENDIX IH-B** **CORE IH FACULTY – SCHOLARLY PUBLICATIONS (7/01/06 – 6/30/07)**

(faculty are listed in **bold** type; students/trainees are underlined)

#### **Books**

1. **Vincent, J.H.** (2007), *Aerosol Sampling: Science, Standards, Instrumentation and Applications*, Wiley and Sons, Chichester, England, U.K. (650 pages).

#### **Peer-reviewed articles**

2. W. H. Steinecker, M. P. Rowe, and E. T. Zellers, "Model of Vapor-Induced Resistivity Changes in Gold-Thiolate Monolayer-Protected Nanoparticle Sensor Films," *Anal. Chem*, 2007, 79, 4977-4986.
3. P. Rowe, W. H. Steinecker, and E. T. Zellers, "Exploiting charge-transfer complexation for selective measurement of gas-phase olefins with nanoparticle-coated chemiresistors," *Anal. Chem.*, 2007, 79 (3), 1164-72. [PMID 17263350]
4. Q. Zhong, R. Veeneman, W. Steinecker, C. Jia, S. Batterman, and E. T. Zellers, "Rapid Determination of ETS Markers with a Prototype Field-Portable GC Employing a Microsensor Array Detector," *J. Environ. Monit.*, 2007, 9(5), 440-448.
5. **C. Jin, P. Kurzawski**, A. Hierlemann, E.T. Zellers (**2007**). Evaluation of Multi-Transducer Arrays for Determinations of Vapor Mixtures, *Anal. Chem*. Under review.
6. **Meeker JD**, Susi P, Pelligrino, A. Comparison of occupational exposures among painters using three alternative blasting abrasives. *J Occup Environ Hyg*, 2006; 3(9): D80-D84. [PMID 16857642]
7. Hauser R and **Meeker JD**. Epidemiologic studies on the relationship between semen quality and environmental chemicals: Historic and contemporary compounds. In: Nicolopoulou-Stamati P, Hens L, Howard CV (eds). Reproductive Health and the Environment. Springer, Berlin: 2007.
8. Hauser R, **Meeker JD**, Duty S, Silva M, Calafat A. Altered semen quality in relation to urinary concentrations of phthalate monoester and oxidative metabolites. *Epidemiology*, 2006; 17(6):682-91. [PMID 17003688]
9. **Meeker JD**, Missmer SA, Cramer DW, Hauser R. Maternal exposure to secondhand tobacco smoke and pregnancy outcome among couples undergoing assisted reproduction. *Hum Reprod*, 2007; 22(2):337-45. [PMID 17053002]
10. Hauser R, Barthold J, **Meeker JD**. Epidemiologic evidence on the relationship between environmental endocrine disruptors and male reproductive and developmental health. In: Gore A (ed). Endocrine-disrupting Chemicals: From Basic Research to Clinical Practice. Humana Press, Totowa, NJ: In Press.

11. **Meeker JD**, Altschul L, Hauser R. Serum PCBs, p,p'-DDE and HCB predict thyroid hormone levels in men. *Environ Res*, 2007; 104(2):296-304. [PMID 17189629]
12. **Meeker JD**, Godfrey-Bailey L, Hauser R. Relationships between serum hormone levels and semen quality among men from an infertility clinic. *J Androl*, 2007; 28(3):397-406. [PMID 17135633]
13. Hauser R, **Meeker JD**, Singh NP, Silva MJ, Ryan L, Duty S, Calafat AM. DNA damage in human sperm is related to urinary levels of phthalate monoester and oxidative metabolites. *Hum Reprod*, 2007; 22(3):688-95. [PMID 17090632]
14. **Meeker JD**, Barr D, Serdar B, Rappaport S, Hauser R. Utility of urinary 1-naphthol and 2-naphthol levels to assess environmental carbaryl and naphthalene exposure in an epidemiology study. *J Expo Sci Environ Epidemiol*, 2007, 17(4), 314-320. [PMID 16721410]
15. Herrick RF, McClean MD, **Meeker JD**, Zwack L, Hanley K. Physical and chemical characterization of asphalt (bitumen) paving exposures. *J Occup Environ Hyg*, In Press. [PMID 17503286]
16. Herrick RF, **Meeker JD**, Hauser R, Altshul L, Weymouth GA. Serum PCB levels and congener profiles among US construction workers. *Environ Health*, In Press.
17. **Meeker JD**, Calafat AM, Hauser R. Di-(2-ethylhexyl) phthalate metabolites may alter thyroid hormone levels in men. *Environ Health Perspect*, In Press.
18. **Meeker JD**, Susi P, Flynn MR. Manganese and welding fume exposure and control in construction. *J Occup Environ Hyg*, In Press.
19. **Meeker JD**, Missmer SA, Vitonis AF, Cramer DW, Hauser R. Risk of spontaneous abortion in women with childhood exposure to parental cigarette smoke. *Am J Epidemiol*, In Press.
20. Sivulka, D., Conard, B.R., Hall, G.W. and **Vincent, J.H.** (2007), Species-specific exposures in the nickel industry: a new approach for deriving occupational exposure limits, *Regulatory Toxicology and Pharmacology*, 48, 19-34.
21. Brixey, L.A. and **Vincent, J.H.** (2006), Aspiration efficiency of IOM-like personal aerosol samplers from experiments with a new rapid data acquisition system, *Aerosol Science and Technology*, 39, 1164-1173.

### Book Chapters

22. Hauser R and **Meeker JD**. Epidemiologic studies on the relationship between semen quality and environmental chemicals: Historic and contemporary compounds. In: Nicolopoulou-Stamati P, Hens L, Howard CV (eds). *Reproductive Health and the Environment*. Springer, Berlin: In Press.

23. Hauser R, Barthold J, **Meeker JD**. Epidemiologic evidence on the relationship between environmental endocrine disruptors and male reproductive and developmental health. In: Gore A (ed). *Endocrine-disrupting Chemicals: From Basic Research to Clinical Practice*. Humana Press, Totowa, NJ: In Press.

#### Patents

24. Patent disclosure: "*Microscale Integrated Sampler-Injector*," UM file # 3673: E. T. Zellers, disclosed on February 19, 2007.

#### Conference Proceedings Papers

25. H. Kim, W. H. Steinecker, G. R. Lambertus, A. A. Astle, K. Najafi, E. T. Zellers, P. D. Washabaugh, L. P. Bernal, and K. D. Wise, Integrated high-pressure 4-stage micro gas pump for high-speed micro gas chromatography, in *Proc. 10th Int. Conf. on Miniaturized Systems for Chemistry and Life Sciences ( $\mu$ TAS 06)*, Tokyo, Japan, Nov. 5-9, 2006, pp. 1037-1039.
26. H. Kim, W. H. Steinecker, G. R. Lambertus, A. A. Astle, K. Najafi, E. T. Zellers, P. D. Washabaugh, L. P. Bernal, and K. D. Wise, "Micropump-driven high-speed MEMS gas chromatography system," *Proc. Transducers '07*, Lyon, FR, June 10-14, 2007, pp. 1701-1703.
27. E. T. Zellers, S. Reidy, R. A. Veeneman, R. Gordenker, W. H. Steinecker, G. R. Lambertus, H. Kim, J. A. Potkay, M. P. Rowe, Q. Zhong, C. Avery, H. K. L. Chan, R. D. Sacks, K. Najafi, K. D. Wise, INVITED, "An Integrated Micro-Analytical System for Complex Vapor Mixtures," *Proc. Transducers '07*, Lyon, FR, June 10-14, 2007, pp. 1688-1691.

## APPENDIX OHN-B

**Publications by program area of faculty and trainees during the reporting period that have resulted, in whole or part, from ERC training grant support.**

### PUBLICATIONS

**Faculty [Faculty names are bolded; OHN Program graduates' names are underlined.]**

Allen, C., **Duffy S.A.**, Teknos, T., Islam, M., Chen, Z., Albert, P., & Van Waes, C. (in press). A prospective study of serial measurement of NF-kB related serum cytokines as biomarkers of response and survival in patients with advanced oropharyngeal squamous cell carcinoma receiving chemoradiation therapy. *Clinical Cancer Res.*

**Barkauskas, V.H.** Schafer, R., Sebastian, J.G, Pohl, J.M., Benkert, R., Nagelkerk, J., Stanhope, M., Vonderheid, S.C., & Tanner, C.L. (2006). Clients served and services provided by academic nurse-managed center. *Journal of Professional Nursing, 22:331-338.*

Benkert, R., George, N., Tanner, C., **Barkauskas, V.H.**, Pohl, J.M., & Marszalek, A. (2007). Satisfaction with school based teen health center: A report card on care. *Pediatric Nursing, 33(2).*

Brady, J. & **Hong, O.** (2006). Work climate and hearing protection behaviors in construction workers. *Professional Safety, 18-26.*

Cheng, S.S., Terrell, J.E., Bradford, C.R., Ronis, D.L., Fowler, K.E., Prince, M.E., Teknos, T.N., Wolf, G.T., & **Duffy, S.A.** (2006). Clinical predictors of feeding tube placement in head and neck cancer patients. *Archives of Otolaryngology and Head and Neck Surgery, 132:655-661.*

**Duffy, S.A.**, Copeland, L., Hopp, F., & Zalenski, R. (in press). Diagnostic classifications and resource utilization of decedents served by the Department of Veterans Affairs. *J. Palliat Med.*

**Duffy, S.A.**, Jackson, F., Schim, S., Ronis, D.L., & Fowler, K. (2006). Cultural concepts at the end of life. *Nursing Older People, 18:10-14.*

**Duffy, S.A.**, Jackson, F., Schim, S., Ronis, D.L., Fowler, K., & Karvonen, C. (2006). Differences in veteran's and non-veteran's end-of-life preferences: A pilot study. *Journal of Palliative Medicine, 9:1099-1105.*

**Duffy, S.A.**, Jackson, F., Schim, S., Ronis, D. L., Fowler, K., & Karvonen, C. (2006). Racial /ethnic preferences, gender preferences, and perceived discrimination related to end-of-life care. *Journal of the American Geriatric Society, 54:150-157.*

**Duffy, S.A.**, Karvonen, C., Hermann, C., Reeves, P., & Smith, P (in press). In-hospital smoking cessation programs: What do VA patients and staff want and need? *Applied Nursing Research.*

**Duffy, S.A.**, Khan, M.J., Ronis, D.L., Fowler, K.E., Gruber, S., Wolf, G., & Terrell, J.E. (in press), Health behaviors of head and neck cancer patients one year after diagnosis. *Head Neck*.

**Duffy, S.A.**, Ronis, D.L., Fowler, K.E., Valenstein, M., Lambert, M., Bishop, C., & Terrell, J.E. (in press). Depressive symptoms, smoking, alcohol use, and quality of life among head and neck cancer patients. *Psychosomatics*, 48(2), 142-148.

**Duffy, S.A.**, Ronis, D.L., Valenstein, M., Lambert, M., Bishop, C., Fowler, K.E., Gregory, L., Bishop, C., Myers, L.L., Blow, F.C., & Terrell, J.E. (2006). A tailored smoking, alcohol, and depression intervention for head and neck cancer patients. *Cancer Epidemiology, Biomarkers and Prevention*, 15(11), 2203-2208.

**Hong, O.**, Ronis, D.L., **Lusk, S.L.**, & Kee, K.S. (2006). Effectiveness of a computer-based hearing test and tailored hearing protection intervention. *International Journal of Behavioral Medicine*, 13(4), 304-314.

**Hong, O.**, & Samo, D. (2007). Hazardous decibel and hearing loss in fire fighters. *Association of American Occupational Health Nurses Journal*, 56(8), 313-319...

**Hong, O.**, Samo, D., Hulea, R., & Elkin, B. (in press). Perceptions and attitudes of fire fighters on noise exposure and hearing loss. *Journal of Occupational & Environmental Hygiene*.

Kerr, M.J., Savik, K., Monsen, K.A., & **Lusk, S.L.** (2007). Effectiveness of computer-based tailoring versus targeting to promote use of hearing protection. *Canadian Journal of Nursing Research*, 39(1): 80-97.

Kerr, M.J., Savik, K., Monsen, K.A., & **Lusk, S.L.** (2007). Effectiveness of computer-based tailoring versus targeting to promote use of hearing protection. *Canadian Journal of Nursing Research*, 39(1): 80-97.

Lambert, M.T., Sampson, N., Copeland, L.A., & **Duffy, S.A.** (2006). New-onset diabetes and body mass index in veteran's prescribed atypical antipsychotic medications. *Progress in Neuro Psychopharmacology & Biological Psychiatry*, 30:919-923.

**Lusk, S. L.**, Raymond, D. M., Connon, C., & Miller, M. (2006). Workers and worker populations. In Salazar, M.K. (Ed.). *Core Curriculum for Occupational & Environmental Health Nursing* (3rd ed.). Philadelphia: W.B. Saunders.

Pohl, J. M., Breer, L., Tanner, C., **Barkauskas, V.**, Bleich, M., Bomar, M., Fiandt, K., Jenkins, M., Lundeen, S., Mackey, T., Nagelkerk, J., & Werner, K. (2006). National consensus on data elements for nurse managed health centers. *Nursing Outlook*, 54(2), 81-84.

Pohl, J. M., Vonderheid, S., **Barkauskas, V.**, & Nagelkerk, J. (2006). Critical elements for tracking financial data in academic nurse managed centers. *American Journal for Nurse Practitioners*, 10(4), 10-16.

Pohl, J.M., **Barkauskas, V.**, Benkert, R., Breer, L., & Bostrom, A., (2007). Impact of academic nurse managed centers on communities served. *Journal of the American Academy of Nurse Practitioners*, 19(5), 268.

Pohl, J.M., **Barkauskas, V.H.**, Benkert, R., Breer, L., & Bostrom, A. (in press). Impact of academic nurse managed centers on communities served. *Journal of the American Academy of Nurse Practitioners*.

Raymond, D.M., & **Lusk, S.L.** (2006). Testing the Transtheoretical Model constructs of Decisional Balance and Self-efficacy as applied to factory workers use of hearing protection. *Nursing Research*, 55(5), 328-335.

Raymond, D.M., & **Lusk, S.L.** (2006). Staging Use of Hearing Protective Devices. *AAOHN Journal*, 54(4), 165-172.

Raymond, D. M., **Hong, O.**, **Lusk, S. L.**, & Ronis, D. L (2006). Comparison of predictors of hearing protection use for Hispanic and Non-Hispanic White factory workers. *Research & Theory for Nursing Practice: An International Journal*, 20(2), 127-140.

Ronis, D. L., **Hong, O.**, & **Lusk, S. L.** (2006). Comparison of the original and revised structures of the health promotion model in predicting construction workers' use of hearing protection. *Research in Nursing and Health*, 29(1), 3-17.

**Sampson, D.A.** (2006). [Book Review]. Silent scars of healing hands: Oral histories of Japanese American doctors in World War II detention camps. Naomi Hirahara and Gwenn M. Jenson. Reviewed for *Oral History Review*, 33(2).

**Sampson, D.A.** (2007). [Review]. Evaluating Prescribing competencies and standards used in nurse-independent prescribers' prescribing consultations: An observational study of practice in England. *Journal of Research in Nursing*, 12 (1) (in press).

**Sampson, D.A.** (in press). Nurse practitioner power over prescribing: Practice boundaries and state law negotiation; New Hampshire case study. Accepted by *Nursing History Review*.

**Thomas A.** (in press). Hispanic and Latino Elders. In *Encyclopedia of Elder Care* (2nd Ed.) Capezuti, L., Siegler, M., & Mezey, M. (eds.).

**OHN PhD graduates** [Note: graduates' names are bolded.]

**Caruso, C.C.**, Bushnell, T., Eggerth, D. Heitmann, A., Kojola, B., Newman, K., Rosa, R.R., Sauter, S.L. & Vila, B. (2006). Long working hours, safety, and health: Toward a national research agenda. *American Journal of Industrial Medicine*, 49(11): 930-942.

**Caruso, C.C.** (2006). Possible broad impacts of long work hours. *Industrial Health*, 44, 531-36.

Waters, T.R., Collins, J., Galinsky, T., & **Caruso, C.C.** (2006). NIOSH research efforts to prevent musculoskeletal injuries and illnesses in the healthcare industry. *Orthopaedic Nursing*, 26(6): 380-89.

**Caruso, C.C.**, & Rosa, R.R. (2007). Shift work and long work hours. *Environmental and occupational medicine*, (4<sup>th</sup> ed.). Lippincott William & Wilkins: Philadelphia.

- Kerr, M.J.** (2007). Hearing conservation (editorial). *AAOHN Journal*, 55(4): 152.
- Kerr, M.J.**, Savik, K., Monsen, K.A., & Lusk, S.L. (2007). Effectiveness of computer-based tailoring versus targeting to promote use of hearing protection. *Canadian Journal of Nursing Research*, 39(1): 80-97.
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- McCullagh, M.** (2006). Home modifications: Nurses can make life at home safer and more convenient as abilities change. *American Journal of Nursing*, 106(10): 56-65.
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## **Appendix OSE-B:**

### **Publications 2006-07**

Student authors are underlined.

Students receiving NIOSH support as trainees or on PPRT-funded projects are **underlined and bolded**.

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Bauerly, M. and Liu, Y. (in press). Effects of Symmetry and Number of Compositional Elements on Interface and Design Aesthetics. *International Journal of Human Computer Interactions*.

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## **DOCTORAL DISSERTATIONS:**

Bauerly, M. *Mathematical Modeling and Experimental Study of Interface* (Advisor: Y. Liu).

Grieshaber, D.C. *Factors Affecting hand Posture and Push Strength During One-Handed Flexible rubber Hose Insertion Tasks* (Advisor: T.J. Armstrong).

Lim, J. *Queuing Network Modeling of Visual Search* (Advisor: Y. Liu).

Seo, N. *Development of a Biomechanical Model of Hand Coupling for Axial Torque and Push Exertions on Cylindrical Handles* (Advisor: T.J. Armstrong).

Womack, S. *A Multi-Methodological Study of the Effects of Lean Manufacturing Practices on Work-Related Musculoskeletal Disorder Risk Factors and Other Injuries* (Advisors: T.J. Armstrong and J.K. Liker)

Wu, C. *Queuing Network Modeling of Human Performance and Workload in Perceptual-Motor Tasks* (Advisor: Y. Liu).

## APPENDIX OE-B

### **Publications and Presentations by Occupational Epidemiology Faculty and Trainees.**

Faculty in **bold**; trainees are underlined.

Cui Y, **Morgenstern H**, Greenland S, Tashkin DP, Mao J, Cao W, Cozen W, Mack TM, Zhang Z-F. Polymorphism of *xeroderma pigmentosa group G* and the risk of lung cancer and squamous carcinomas of the oropharynx, larynx, and esophagus. *Int J Cancer* 2006; 118:714-720.

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Invited Presentation. The University of Michigan Dioxin Exposure Study: Project Overview. **Franzblau, A; Garabrant, D**; Adriaens, P; Gillespie, BW; Demond, A; Olson, K; Ward, B; Hedgeman, E; Knutson, K; Zwica, L; Towey, T; Chen, Q; Ladronka, K; Sinibaldi, J; Chang, S; Lee, S; Gwinn, D; Sima, C; Swan, S; Lepkowski, J. Dioxin 2006 Conference, Oslo, Norway. August 21, 2006

Invited Presentation. Prevalence of Exposure Routes in The University of Michigan Dioxin Exposure Study: Food Consumption, Recreational and Household Activities, Occupations and Demographics. Olson, K; Lepkowski, J; Ward, B; Ladronka, K; Sinibaldi, J; **Franzblau, A**; Adriaens, P; Gillespie, B; Bandyk, J; Chang, Sc; Chen, Q; Demond, A; Gwinn, D; Hedgeman, E; Knutson, K; Lee, S; Sima, C; Swan, S; Towey, T; Zwica, L; **Garabrant, D**. Dioxin 2006 Conference, Oslo, Norway. August 21, 2006

Invited Presentation. Measurements of Soil Concentrations of PCDDs, PCDFs, and PCBs From a Community in Michigan, USA. Adriaens, P; Demond, A; Towey, T; Chang, Sc; Chen, Q; **Franzblau, A; Garabrant, D**; Gillespie, B; Gwinn, D; Hedgeman, E; Hong, B; Knutson, K; Ladronka, K; Lee, Cy; Lepkowski, J; Olson, K; Sima, C; Sinibaldi, J; Ward, B; Zwica, L. Dioxin 2006 Conference, Oslo, Norway. August 21, 2006

Invited Presentation. Measurements of Household Dust Concentrations of PCDDs, PCDFs, and PCBs From a Community in Michigan, USA. **Zwica, L; Knutson, K**; Towey, T; **Hedgeman, E; Franzblau, A**; Chen, Q; Lee, S-Y; Sima, C; Gillespie, B; Adriaens, P; Demond, A; Lepkowski, J; Ward, B; Ladronka, K; Olson, K; Sinibaldi, J; Chang, S-C; Gwinn, D; Swan, S; **Garabrant, D**. Dioxin 2006 Conference, Oslo, Norway. August 21, 2006

Invited Presentation. Measurements of Serum Concentrations of PCDDs, PCDFs, and PCBs From a Community in Michigan, USA Hedgeman, E; Chen, Q; Gillespie, BW; **Franzblau, A; Knutson, K; Zwica, L**; Sima, C; Lee, S-Y; Lepkowski, J; Ward, B; Ladronka, K; Olson, K; Sinibaldi, J; Towey, T; Adriaens, P; Demond, A; Chang, S-C; Gwinn, D; Swan, S; **Garabrant, D**. Dioxin 2006 Conference, Oslo, Norway. August 21, 2006

Invited Presentation. Environmental Factors That Explain Variation in Serum Dioxin Concentrations in a Community in Michigan, USA. **Garabrant, D.H.; Franzblau, A**; Lepkowski, J; Adriaens, P; Demond, A; Hedgeman, E; Knutson, K; Zwica, L; Chen, Q; Olson, K; Ward, B; Towey, T; Ladronka, K; Sinibaldi, J; Chang, S-C; Gwinn, D; Sima, C; Swan, S; Gillespie, B. Dioxin 2006 Conference, Oslo, Norway. August 21, 2006

Invited Presentation. Analysis of Patterns in PCDD, PCDF, and PCB Soil Concentrations From a Community in Michigan, USA. Chang, S-C; Adriaens, P; Towey, T; Wright, D; Demond, A; Gillespie, B; **Franzblau, A; Garabrant, D**. Dioxin 2006 Conference, Oslo, Norway. August 21, 2006

Abstract. Environmental Factors That Explain Variation in The Upper Percentiles of Serum Dioxin Concentrations in a Community in Michigan, USA. Chen, Q; Lee, S-Y; Hedgeman, E; Olson, K; Little, RJA; Elliott, MR; Gillespie, BW; Lepkowski, J; **Garabrant, D**; **Franzblau, A**. Dioxin 2006 Conference, Oslo, Norway. August 21, 2006.

Abstract. Comparison of Machine Learning Methods and Linear Regression Models in Identifying Important Predictor Variables For Serum Dioxin TEQ For a Community in Michigan, USA. Chen, Q; Lee, S-Y; Hedgeman, E; Ghosh, D; Gillespie, BW; Lepkowski, J; **Garabrant, D**. Dioxin 2006 Conference, Oslo, Norway. August 21, 2006.

Abstract. Methods For Sampling and Analyzing Soil For The University of Michigan Dioxin Exposure Study. Demond, A; Towey, T; Chang, SC; Adriaens, P; Luksemburg, W; Maier, M; Favaro, K; Wenning, R; Kennington, B.P. Dioxin 2006 Conference, Oslo, Norway. August 21, 2006.

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## APPENDIX HSAT-B

### **CORE HSAT FACULTY – SCHOLARLY PUBLICATIONS (7/01/06 – 6/30/07)** (faculty are listed in **bold** type; students/trainees are underlined)

#### Peer-reviewed articles

1. S.M. Chernyak, **S.A. Batterman**, Temporal (1983-2005) and Spatial Trends of Polybrominated Diphenyl Ethers in Great Lakes Rainbow Smelt and Lake Trout,” *Organohalogenated Compounds*, **69**: 716-9 (2006).
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5. Hautamäki M, P. Kalliokoski, M. Hyttinen, P. Pasanen, J. Laitinen, J. Kangas, **S Batterman**, “Evaluation of The Use of Low Flow Passive Sampling Technique In Offset Printing Plants”, *International Journal of Occupational Medicine and Environmental Health*, **19**, 4, 228-34, 2006. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1600-0668.2006.00459.x>
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8. S.M. Charles, **S. Batterman**, C. Jia, “VOC Compositions and Emissions of Main- and Side-Stream Cigarette Smoke,” 2007. *Atmospheric Environment* (online 7/07) <http://dx.doi.org/10.1016/j.atmosenv.2007.02.020>
9. Q. Zhong, R. Veeneman, W.H. Steinecker, C. Jia, **S.A. Batterman**, E.T. Zellers, “Rapid Determination of ETS Markers with a Prototype Field-Portable GC Employing a Microsensor Array Detector”, *Journal of Environmental Monitoring*, **9**, 440-8. 2007. [DOI: 10.1039/b700216e](http://dx.doi.org/10.1039/b700216e)
10. **S. Batterman**, S. Chernyak, E. Gwynn, D. Cantonwine, C. Jia, L. Begnoche, J.P. Hickey, “Trends of Brominated Diphenyl Ethers in Fresh and Archived Great Lakes Fish (1979-2005),” *Chemosphere*, **69**, 444-457, 2007. <http://dx.doi.org/10.1016/j.chemosphere.2007.04.066>

11. W. Wei, **S. Batterman**, S. Chernyak, J. Nriagu, "Concentrations and Risks of Organic and Metal Contaminants in Eurasian Caviar," *Journal of Ecotoxicology and Environmental Safety*. (in press) 2007. <http://dx.doi.org/10.1016/j.ecoenv.2007.06.007>

#### **Conference Proceedings Papers**

1. **S. Batterman**, C. Godwin, C. Jia., "Biological monitoring for VOCs," presented at Workshop on the Interpretation of Biomonitoring Data and their relationship to Exposure Information, American Chemistry Council, Minneapolis, MN, July 26-27, 2006.
2. **S. Batterman**, C. Jia, C. Godwin, G. Hatzivasilis, "A Dominant Source of VOC Exposure: Attached Garages," presented at the International Conference on Environmental Epidemiology & Exposure, Sept. 2-6, 2006, Paris, France.
3. Le, H; **S. Batterman**, K. Dombkowski, R. Walh, J. Wirth, E. Wasilevich, M. Depa, "A Comparison Of Multiple Imputation And Optimal Estimation For Missing And Uncertain Urban Air Toxics Data," presented at the International Conference on Environmental Epidemiology & Exposure, Sept. 2-6, 2006, Paris, France.
4. Jafta N, Gqaleni N, **Batterman S**, Naidoo R, Robins T. Allergen levels in the residences and schools in primary school children in Durban, Paper presented at the 3rd National Public Health Conference, Johannesburg, South Africa, May 16-17, 2006.
5. Sikhosana N, Jafta N, Gqaleni N, Naidoo R, **Batterman S**, Robins T. Indoor concentration of particulate matter and carbon monoxide in the south and north of Durban. Paper presented at the 3rd National Public Health Conference, Johannesburg, South Africa, May 16-17, 2006. [*Nominated new researcher presentation*]
6. Gounden Y, Batterman S, Naidoo R. The Durban south Health study: Exposure monitoring. Poster presented at the 3rd National Public Health Conference, Johannesburg, South Africa, May 16-17, 2006. [*Awarded best new researcher poster*]
7. Chernyak S, **Batterman S**, Gwynn E, Jia C, Begnoche L, "Temporal (1983-2005) and spatial trends of polybrominated diphenyl ethers in great lakes rainbow smelt and lake trout," to be presented at Dioxin 2006, Oslo, Norway, Aug. 21-5, 2006.
8. **S. Batterman**, S. Chernyak, Y Gounden, M Matookane, "Concentrations of persistent organic pollutants in ambient air in Durban, South Africa," Dioxin 2006, Oslo, Norway, Aug. 21-5, 2006.
9. **S. Batterman**, C. Godwin, C. Jia, "Design and Evaluation of a New Breath Monitoring System for Volatile Organic Compounds," presented at the International Council of Chemical Association (ICC) Biomonitoring Workshop, Minneapolis, MN, July 26-7, 2006. Invited.

10. F. Freire, C.H. Antunes, M.C. Gameiro, **S. Batterman**, A.G. Martins, "Energy for sustainability (EfS): An initiative of the University of Coimbra, 10<sup>th</sup> meeting of the Alliance for Global Sustainability, Barcelona, Spain, March 18-21, 2007.
11. R. Poovendhree, R. Naidoo<sup>1</sup>, R. Naidoo, T.G. Robins, G. Mentz, S.J. London, **S. Batterman**, "Effect modification of respiratory responses to ambient air pollutants by GSTM1, GSTP1 and NQO1 polymorphisms," American Thoracic Society International Conference, San Francisco, May 18-23, 2007.
12. **S. Batterman**, S. Chernyak, W Wang, J Nriagu, "Organic and Metal Contaminants in Eurasian Caviar: Trends & Risks" submitted to SETAC Europe 17th Annual Meeting in Porto, May 20-24, 2007.
13. S Chernyak, **S. Batterman**, Y Youden, M. Matoonane, R. Naidoo, "Persistent and currently used pesticides in South African air, SETAC Europe 17th Annual Meeting in Porto, May 20-24, 2007.
14. S Chernyak, **S. Batterman**, A Konoplev, A Kochetkov, C Godwin, C Jia, S Charles. "Fate of Brominated Flame Retardant Chemicals in Russian and US Buildings," SETAC Europe 17th Annual Meeting in Porto, May 20-24, 2007.
15. JY Chin, F Freire, J Malaca, **S. Batterman**, "Incorporating local scale impacts into LCAs: Comparing conventional and ethanol fuels," SETAC Europe 17th Annual Meeting in Porto, May 20-24, 2007.
16. J Kistnasamy, TG Robins, **S. Batterman**, G Mentz, R Naidoo, U Lalloo, E Iruksen, C Jack. "The relationship between asthma and outdoor air pollution among primary school learners in Durban, South Africa," submitted to the 4th International Conference on Children's Health and the Environment, Vienna, Austria, June 10-12, 2007.
17. **S. Batterman**, "Management Systems for Health Care Waste. 1<sup>st</sup> Annual Infection Prevention and Control Meeting, Maputo, Mozambique. June 4, 2007.

**PILOT PROJECT RESEARCH TRAINING PROGRAM APPENDICES:**

- Appendix PPRT – 1. University of Michigan PPRT Faculty Advisors
- Appendix PPRT – 2. 2006-07 Program Announcement
- Appendix PPRT – 3. Scoring Sheet used by Scientific Review Committee
- Appendix PPRT – 4. Summary of Funded Pilot Projects – Reporting Year (2006-07)
- Appendix PPRT – 5. Updated List of Publications, Proposals, and Placements
- Appendix PPRT – 6. Summary of Funded Pilot Projects – 1999-2007
- Appendix PPRT – 7. Summary of Funded Pilot Projects – Next Year (2007-08)

**Appendix PPRT – 1.  
University of Michigan PPRT Faculty Advisors**

<u>Faculty Member</u>	<u>Areas of Expertise</u>
Thomas Armstrong, Ph.D.	Upper Extremity CTDs, Rehabilitation Ergonomics
Violet Barkauskas, Ph.D.	Evaluation of Health Promotion/Risk Reduction Programs, Outcomes of Community-based Nursing Services
Stuart Batterman, Ph.D.	Hazardous Waste, Environmental Science
Don Chaffin, Ph.D.	Low Back Pain, Manual Materials Handling, Digital Modeling
Alfred Franzblau, M.D.	Work-related MSDs, Pulmonary Disease, Biological Monitoring
David Garabrant, M.D.	Occupational and Environmental Cancer Epidemiology
Paul Green, Ph.D.	Design of Interactive Displays and Controls, Cognitive Ergonomics
Bonnie Haggerty, Ph.D.	Occupational psychosocial stress and depression
Howard Hu, M.D.	Occupational Medicine and Epidemiology.
Barry Kantowitz, Ph.D.	Transportation Safety, Cognitive Ergonomics
Monroe Keyserling, Ph.D.	Safety Engineering, Postural Biomechanics, Rehab. Ergonomics
Yili Liu, Ph.D.	Cognitive Ergonomics, Human/computer Interaction
Bernard Martin, Ph.D.	Vibration, Work Physiology
John Meeker, Sc.D.	Exposure Assessment
Thomas Robins, M.D.	Solvent Neurotoxicity, Occupational Nephropathy, Inhalation Toxicology, Evaluation of OH&S Training Programs
Nadine Sarter, Ph.D.	Human Error, Multi-modal display systems
Patricia Strasser, Ph.D.	Psychological Stress and Upper Extremity Disorders
James Vincent, Ph.D., Sc.D.	Aerosol Science, Exposure Assessment, Occupational Health Standards, Computational Fluid Dynamics
Reg Williams, Ph.D.	Workplace interventions for depression
Chuanwu Xi, Ph.D.	Integrated biosensors for environmental monitoring

Edward Zellers, Ph.D.

Air Sampling, Instrumentation, PPE, Exposure  
Assessment

**Appendix PPRT – 2.  
2006-07 Pilot Project Program Announcement**

**FINAL ANNOUNCEMENT:  
Support for Pilot Research Projects in Occupational Health and Safety**

The University of Michigan Center for Occupational Health and Safety Engineering (UM-COHSE), a NIOSH Education and Research Center (ERC) invites proposals for pilot research training projects in occupational safety and health for the period November 1, 2006 through June 30, 2007. It is anticipated that a single project will be funded under this initiative. This program is open to students and faculty at colleges and universities in HHS Region V (the Great Lakes Region) and nearby states. This program is open to students and faculty at The University of Michigan and other colleges and universities in HHS Region V (the Great Lakes Region) and nearby states.

Applications are invited from the following groups:

The University of Michigan

- Ph.D. students enrolled in UM-COHSE programs (Industrial Hygiene/HSAT, Occupational Health Nursing, Occupational Epidemiology, and Occupational Safety and Ergonomics)
- Junior faculty (non-tenured) affiliated with UM-COHSE programs
- University of Michigan Ph.D. students, post-doctoral fellows, and junior faculty in non- UM-COHSE programs who wish to develop or enhance their OH&S research capabilities

Other Universities in HHS Region V and Nearby States

- Ph.D. students and junior faculty who wish to develop or enhance their OH&S research capabilities.

A principal objective of this program is the support of research training, therefore all applications must demonstrate that the proposed work will increase the number and quality of scientists who pursue research careers in occupational health and safety disciplines. Consistent with this goal, an individual is eligible to receive only one grant as a pilot project research trainee over the course of his/her career. (Note: This rule does not limit the number of doctoral students that a faculty member can supervise as research trainees.) The program also focuses on pilot research, i.e., innovative studies that generate preliminary results that will lead to applications for traditional peer-reviewed research grants (e.g., NIH R01, R03, etc.) in occupational health and safety disciplines. This program is not intended to support pilot research performed by senior faculty in the absence of a strong research training purpose.

**DEADLINE FOR APPLICATIONS**

The deadline for applications is 5:00 PM, Friday, September 29, 2006. Submit to:  
W. Monroe Keyserling, Ph.D.  
Director, Pilot Project Research Training Program  
The University of Michigan  
1205 Beal Avenue  
Ann Arbor, MI 48109-2117

## **Submitting Applications:**

Electronic: Electronic submission of applications is requested. To submit electronically, the entire application package must be converted to a single pdf file. The file should be submitted as an e-mail attachment to Ms. Haack-Withem at the following address:

[wmkeyser@umich.edu](mailto:wmkeyser@umich.edu)

Mail: Mail applications will still be accepted, provided that they are postmarked by the September 29 deadline. If you submit by mail, you must send **six** copies of the entire application.

## **Budget Requirements and Restrictions**

Each application must provide a detailed budget and budget justification using the PHS Form 398 format. The maximum amount that will be awarded is \$20,000; however the average pilot project award is only \$16,980. If the awarded amount is not sufficient to support the proposed work, the applicant must demonstrate the availability of matching funds to assure that all project goals will be achieved by the June 30, 2007 deadline. Only direct costs will be supported.

Budgets may include the following cost categories: necessary equipment and supplies, subject fees, travel costs to collect data, and the cost of necessary research personnel. If support is requested for a doctoral student research trainee, the maximum stipend may not exceed \$1731 per month. As a general rule, funding will not be approved for the following costs: faculty salaries, secretarial support for pilot research projects, and tuition for research trainees. Salary support for the research trainee should not exceed 50% of the total project budget.

June 30, 2007 is the absolute last day for any charges to a pilot project account. Any charges incurred after this date will not be reimbursed.

## **Faculty Oversight of Research Training**

Proposals that support a doctoral student as the research trainee must have a faculty sponsor who will serve as the Principal Investigator and will be held responsible for the scientific and fiscal integrity of the project. The PI is also responsible for submitting all reports in a timely manner. The faculty sponsor must serve on the “graduate faculty” of the applicant institution. (A member of the “graduate faculty” has been approved by his/her institution to serve as chair of a doctoral dissertation committee.) The research trainee will serve as a co-Principal Investigator on the project.

## **Reporting Requirements**

A brief mid-year progress report must be submitted no later than March 1, 2007 and cover the following topics:

- Progress to date
- Timeline for completing research tasks
- Plans for publications
- Plans for follow-up research (including anticipated grant applications)

A final report must be submitted no later than August 1, 2007. The final report must include the following sections:

- Executive Summary (1 page single-spaced)
- Final Technical Report (approximately 20-30 pages, double spaced, plus references and relevant appendices)
- Abstracts of submitted or planned publications
- Plans for follow-up grant applications

Principal Investigators are responsible for submitting the mid-year and final reports by the February and August deadlines.

In addition to the above reports, copies of all publications resulting from the project must be submitted to the Pilot Research Training Program Administrator.

### **Research Involving Humans or Animal Subjects**

All projects involving either human or animal subjects must be reviewed and approved by the appropriate Institutional Review Board. A completed copy of the IRB application must be included with the proposal as a separate document. (When submitting electronically, the IRB application must be submitted as a separate file). Please make careful note of the following requirements:

1. The project title and PI on the IRB application (and IRB approval letter) must be an exact match to the project title and PI on the pilot project proposal.
2. The letter from the IRB must give the names and roles of key research participants. If the project is performed by a Ph.D. student, the IRB letter must list the faculty member as the Principal Investigator and the student as the Research Trainee.
3. Any proposal that does not include a copy of the IRB application will be considered incomplete and will be returned without review.

Note: If the proposal is approved for funding, a copy of the IRB approval letter must be submitted to the Director of The University of Michigan Pilot Project Research Training Program before any funds will be released. **Investigators are STRONGLY ENCOURAGED to apply for IRB approval as soon as possible. NIOSH will not release funds and research may not begin until all IRB documentation is submitted.** (Note: In previous years, several projects have been delayed by several months due to slowness in IRB approvals. This has created problems in meeting the June 30 deadline for completing the pilot project research.)

### **Proposal Format and Evaluation Criteria**

#### Format for Technical Proposal

**All proposals submitted to the Pilot Project Research Training Program will be limited to a maximum of five single-spaced pages, and must conform to the following format:**

- Abstract (1/2 page maximum, does not count toward page limit)
- Specific Aims (1/2 page maximum)
- Significance (1 page maximum)
- Qualifications of Investigator (includes related research/professional experience of research trainee, 1 page maximum)
- Research Plan (must include quarterly milestones and end of year deliverables, 3 pages maximum)
- Current and Future Sources of Support (1 page maximum)

Note: Any application that exceeds the five page limit will be returned without review.

### Additional Required Sections

In addition to the five-page technical proposal, each application must include the following appendices:

- A. Budget and Justification (submitted using PHS Form 398 budget format)
- B. Curriculum vitae of Research Trainee and Faculty Sponsor
- C. Letter of support from Faculty Sponsor
- D. Time Line showing start/completion times of major activities
- E. Documentation of other sources of support during the budget period (if applicable)
- F. Letter(s) of support from regional stakeholder(s) (if applicable)
- G. References cited in the proposal
- H. Attached as separate file: Completed copy of Human Use IRB application (if applicable). If submitted by paper, only one copy is required.

### Evaluation

Proposals will be reviewed by the Pilot Research Project Scientific Review Committee during the month of June. Proposals will be scored on a 100-point quality scale, using the following weighting factors:

Relevance to NORA priorities and regional needs (including: 1) evidence of support from employer, employee, and/or academic stakeholders, and 2) likelihood of developing effective workplace interventions)  
25 points

Preparation of investigator to perform proposed work  
10 points

Adequacy of resources (faculty advisors, laboratories, computers, access to work sites, etc.) required to complete the pilot project  
10 points

Innovativeness and scientific merit; adequacy and feasibility of experimental plan  
40 points

Building research capacity of investigator (likelihood of applicant's success in obtaining future funding from conventional sources)  
15 points

### **NORA Priority Areas:**

- Dermatitis
- Asthma and Chronic Obstructive Pulmonary Disease
- Fertility and Pregnancy Abnormalities
- Hearing Loss
- Infectious Diseases
- Low Back Disorders
- Musculoskeletal Disorders of the Upper Extremity

- Traumatic Injuries
- Emerging Technologies
- Indoor Environment
- Mixed Exposures
- Organization of Work
- Special Populations at Risk
- Cancer Research Methods
- Control Technology and PPE
- Exposure Assessment Methods
- Health Services Research
- Intervention Effectiveness Research
- Risk Assessment Methods
- Social and Economic Consequences of Workplace Illness and Injury
- Surveillance Research Methods

**Appendix PPRT – 3.  
Scoring Sheet used by Scientific Review Committee**

**Pilot Research Proposal Review Sheet  
University of Michigan Education and Research Center**

Project Title: \_\_\_\_\_

Investigator: \_\_\_\_\_

Reviewer: \_\_\_\_\_

Proposals are scored on a 100-point quality scale, using the following weighting factors:

1. Relevance to NORA priorities\* and regional needs\*\*:  
Maximum score = 25 points \_\_\_\_\_
  2. Preparation of investigator to perform proposed work  
Maximum score = 10 points \_\_\_\_\_
  3. Adequacy of resources (faculty advisors, laboratories, computers,  
access to work sites, etc.) required to complete the pilot project  
Maximum score = 10 points \_\_\_\_\_
  4. Innovativeness and scientific merit; adequacy and feasibility  
of experimental plan  
Maximum score = 40 points \_\_\_\_\_
  5. Building research capacity of investigator (likelihood of applicant's  
success in obtaining future funding from conventional sources)  
Maximum score = 15 points \_\_\_\_\_
- TOTAL SCORE \_\_\_\_\_

BUDGET RECOMMENDATION:

Fund at requested level: Yes No

If requested budget is not recommended, please suggest reductions below:

**Appendix PPRT – 4.  
Summary of Funded Pilot Projects – Current Year (2006-07)**

*Note: Project numbers are based on the serial number of all funded pilot projects. During the first six years (July 1999-June 2006), we funded 27 projects. The beginning number for the 2006-07 funding cycle is #28.*

**Project #28**

Institution: The University of Michigan  
Core Area: Industrial Hygiene  
Research Trainee: Chuanwu Xi, Ph.D., Assistant Professor, Department of Environmental Health Sciences  
Title: Microbial Characterization of Metal Removal Fluids and Associated Biofilms Using Molecular Approaches  
NORA Area(s): Infectious Diseases, Indoor Environments, Exposure Assessment Methods, Asthma and Chronic Obstructive Pulmonary Disease  
Direct Cost Budget: \$15,400  
Funding Period: July 2006-June 2007

**Abstract:**

Each year, billions of gallons of metal removal fluids (MRFs) are consumed in manufacturing for purposes such as metalworking (e.g., cooling and lubrication), surface preparation (e.g., cleaning and pickling), and finishing (e.g., coating and plating). A number of human health effects have been associated with exposure to MRFs, including various respiratory diseases, skin conditions, and cancers. It has become clear that the growth of microorganisms in MRFs may cause health hazards to workers. Several molecular techniques have been developed for the purpose of characterizing microorganisms in MRFs; however, no comprehensive study of microbial communities in MRFs has been reported yet. In this pilot project, we will develop and validate different molecular techniques for microbial characterization of MRFs samples. We will use the validated molecular methods to characterize microbial composition in detail in MRFs and to quantify the abundance of *Mycobacteria*, specifically *M. immunogenum* and *Pseudomonades* in MRFs environments including bulk fluids, biofilms and possibly bioaerosols to elucidate a possible critical role of biofilms in the microbial ecology in MRFs.

**Project #29**

Institution: The University of Michigan  
Core Area: Industrial Hygiene  
Research Trainee: Simone Charles, Ph.D., Post-doctoral Research Fellow, Department of Environmental Health Sciences  
Faculty Sponsor: Stuart Batterman, Ph.D., Professor, Department of Environmental Health Sciences  
Title: Post-doctoral Training in Exposure Assessment of Emerging Contaminants in the Indoor Environment  
NORA Area(s): Indoor Environments, Exposure Assessment Methods  
Direct Cost Budget: \$20,000  
Funding Period: July 2006-June 2007

**Abstract:**

Brominated flame retardants (BFRs) such as polybrominated diphenyl ethers (PBDEs) and biphenyl are widely used in plastics, textiles, foams and electronic equipment. These contaminants are of great concern as body burdens are increasing at an exponential rate in both occupationally-exposed workers and in the general public. The emission sources and transport pathways that cause these exposures are poorly understood, particularly in the workplace. The available but limited measurements show that indoor concentrations of BFRs are high and greatly exceed outdoor levels. Because indoor and workplace environments are known to contain these materials, and since indoor levels appear to accumulate due to the presence of these sources and the slow rate of degradation, industrial and commercial buildings may represent an important exposure source. To date, however, the literature contains few occupational exposure studies that have characterized BFRs, and all of the identified studies have been conducted in Europe, though much higher exposures have been reported in North America. The proposed research aims to better understand occupational exposures of BFRs by characterizing their distribution and emissions in both commercial and industrial buildings. Emissions from indoor materials will be quantified by measuring vapor and particulate phase BFR-related compounds at 12 industrial and 12 commercial sites. At each site, we will measure incoming (outdoor) and exiting (indoor) BFR concentrations; determine air exchange rates using tracer gas techniques; assess building volume and other building parameters; and conduct a building walkthrough audit. Emission rates will be derived from the collected data by mass balance. Complementary but separate work will characterize these compounds in residential environments for comparison.

### **Project #30**

Institution: The University of Michigan  
Core Area: Occupational Safety and Ergonomics  
Research Trainee: NaJin Seo  
Faculty Sponsor: Thomas J. Armstrong, Ph.D., Professor, Department of Industrial and Operations Engineering  
Title: Development of a Biomechanical Model for Torque and Thrust Strength on Cylindrical Handles  
NORA Area(s): Musculoskeletal Disorders of the Upper Extremity, Traumatic Injuries  
Direct Cost Budget: \$19,360  
Funding Period: July 2006-June 2007

### **Abstract:**

The aim of this work is to develop models for predicting the capacity of the hand to apply torque and thrust force about and along the long axis of cylindrical handles. More specifically, this work will develop a biomechanical model of isometric or "quasi isometric" torque and thrust force that can be exerted on cylindrical handles of a given diameter and surface friction when gripped at a given angle.

Our proposed biomechanical model and preliminary research show that torque strength about the long axis of a cylindrical handle is greater when torque is applied in the direction of the fingers than in the direction of the thumb.

The proposed study will 1) validate the biomechanical model for various handle materials. It will also examine 2) the effect of torque on pushing and pulling along the long axis of the handle and 3) the effect of grip force on wrist flexion and extension

strength. In addition, the coefficient of friction will be measured for different parts of the hand with different normal force levels and handle materials.

The models developed in this study can be used to establish force design limits for work tasks that will accommodate desired percentiles of the male and female population. They also can be used to design equipment that minimizes force requirements, localized fatigue and the risk of work-related musculoskeletal disorders.

**Project #31**

Institution: The University of Michigan  
Core Area: Occupational Safety and Ergonomics  
Research Trainee: Sarah Womack  
Faculty Sponsor: Jeffrey K. Liker, Ph.D., Professor, Department of Industrial and Operations Engineering  
Title: Modeling the Relationship between Work-related Musculoskeletal Disorder Risk Exposure and Lean Manufacturing  
NORA Area(s): Musculoskeletal Disorders of the Upper Extremity, Organization of Work  
Direct Cost Budget: \$14,300  
Funding Period: July 2006-June 2007

**Abstract:**

This project examines the effects of lean manufacturing practices on work-related musculoskeletal disorder (WMSD) risk exposure. Japanese Management Systems have come under scrutiny because some believe that lean production methods increase the prevalence of WMSD injuries compared to traditional management systems.

Two studies will be conducted to:

1. Determine if there is a difference in the organization of work between exemplar lean and quasi-lean work sites.
2. Determine if there is a direct and measurable relationship between lean manufacturing practices and WMSD risk exposure
3. Gain insight into how the exemplar lean organizations manage and integrate productivity, ergonomics, and safety

To investigate the degree of leanness, the lean factors that will be examined at the plant level for both studies include quality, inventory, workforce flexibility and involvement in problem solving. Lean factors at the job level include wasteful motions in the job cycle such as walking, waiting, and unnecessary handling of parts and tools. The WMSD factors that will be evaluated include forceful exertions, repetition, and awkward postures of the wrist, shoulder and trunk.

**Appendix PPRT – 5**  
**Updated Pilot Project Publications, Proposals, etc.**  
**(since last progress report)**

*Note: Project numbers are based on the serial number of all funded pilot projects. This appendix reports all publications, proposals, and job changes of pilot project trainees that have occurred since the last progress report submitted with our competitive renewal application in July 2004.*

**Project #1**

Institution: The University of Michigan  
Core Area: Occupational Safety and Ergonomics  
Faculty Sponsor: Thomas J. Armstrong, Ph.D.  
Research Student: Matthew Marshall, Ph.D. student, Industrial and Operations Engineering  
Title: Quantifying Forceful Manual Exertions in Industry  
NORA Area(s): Musculoskeletal Disorders  
Direct Cost Budget: \$12,225  
Funding Period: July 1999 – June 2000

**Papers and Presentations:**

Marshall, M.M., Armstrong, T.J., and Ebersole, M. "Verbal estimation of peak force," 45th Annual Meeting of the Human Factors and Ergonomics Society, 1026-1030, 2001.

Marshall, M.M. and Armstrong, T.J. (2004). "Observational assessment of forceful exertion and the perceived force demands of daily activities," Journal of Occupational Rehabilitation, 14(4):281-294, 2004.

**Project #2**

Institution: The University of Michigan  
Core Area: Occupational Health Nursing  
Faculty Sponsor: Sally L. Lusk, Ph.D.  
Research Student: Oisaeng Hong, Post-Doctoral Fellow, Health Promotion & Risk Reduction  
Title: Noise Induced Hearing Loss and Hearing Protection in African-American Workers  
NORA Area(s): Hearing Loss and Special Populations at Risk  
Direct Cost Budget: \$12,667  
Funding Period: July 1999 – June 2000

**Current Position of Research Trainee:**

Associate Professor, School of Nursing, The University of California, San Francisco

**Papers and Presentations:**

Hong, O., Lusk, S.L., and Ronis, D.L. "Ethnicity differences in predictors for hearing protection behavior in Black and White workers," Research & Theory for Nursing Practice: An International Journal, 19(1), 63-76, 2005.

**Proposals Submitted/Funded:**

P30-Michigan Center for Health Intervention (MICHIN), NINR, "NIHL-Expert (NIHL-e) System Intervention: Developmental Stage I", Funded.

NIOSH & NIDCD, Competing Continuation “Effectiveness of computer-based training: NIHL-e”, in preparation of resubmission, 2R01 OH004034-04A1

Pusan National University, Republic of Korea, “Web-based survey for hearing protection behavior among workers in six power plants in Korea”, Funded.

**Project #3**

Institution: The University of Wisconsin at Madison  
Core Area: Occupational Safety and Ergonomics  
Faculty Sponsor: Robert G. Radwin, Ph.D.  
Research Student: Jia-Hua Lin, Ph.D. student, Industrial Engineering  
Title: A Biomechanical Model of Ergonomic Design and Selection of Hand Tools  
NORA Area(s): Musculoskeletal Disorders  
Direct Cost Budget: \$12, 944  
Funding Period: July 1999 – June 2000

**New Publication:**

Lin, J. H., Radwin, R. G., and Nembhard , D. A., Ergonomics applications of a mechanical model of the human operator in power hand tool operation, *Journal of Occupational and Environmental Health*, 2(2), 111-9, 2005.

**Project #5**

Institution: The University of Michigan  
Core Area: Occupational Safety and Ergonomics  
Faculty Sponsor: Thomas J. Armstrong, Ph.D.  
Research Student: Christian Grieshaber, Ph.D. student, Industrial and Operations Engineering  
Title: A Biomechanical Model of the Hand and Wrist  
NORA Area(s): Musculoskeletal Disorders  
Direct Cost Budget: \$14,595  
Funding Period: July 2000 – June 2001

**Current Position of Research Trainee:**

Mr. Grieshaber is an Assistant Professor of Safety in the Department of Health Sciences at Illinois State University. He expects to defend his dissertation in 2007.

**New Publications:**

Grieshaber, D.C. and T.J. Armstrong (2004). Characterization of hand postures employed by industrial workers during hose installation tasks. Proceedings of the Human Factors and Ergonomics Society 48th Annual Meeting (not previously reported).

Grieshaber, D.C., T.J. Armstrong and N.J. Seo (2005). How does method affect forearm muscle activity during flexible hose insertion tasks? Proceeding of the 29th Annual Meeting of the American Society of Biomechanics/XXth Congress of the International Society of Biomechanics

Grieshaber, D.C., T.J. Armstrong and N.J. Seo (2006). Changes in the grasp envelope during rubber hose insertion tasks. Proceedings of the XVIth Triennial Congress of the International Ergonomics Association, Maastricht, The Netherlands.

Grieshaber, D.C. and T.J. Armstrong (2006). Insertion Loads and Forearm Muscle Activity During Flexible Hose Insertion Tasks. *Human Factors*. In review.\*

### **Project 7**

Institution: The University of Wisconsin at Madison  
Core Area: Occupational Safety and Ergonomics  
Faculty Sponsor: Robert G. Radwin, Ph.D.  
Research Student: Mary Sesto, Ph.D. student, Industrial Engineering)  
Title: The Effects of Eccentric Contractions on Muscle Mechanical Properties  
NORA Area(s): Musculoskeletal Disorders  
Direct Cost Budget: \$16,300  
Funding Period: July 2000-June 2001

### **Current Position of Research Trainee:**

Dr. Sesto has been promoted to Associate Scientist, University of Wisconsin-Madison, Department of Biomedical Engineering and Trace Center.

### **New Publication:**

Sesto, M. E., Radwin, R. G., and Richard, T. G., "Short-term changes in upper extremity dynamic mechanical response parameters following power hand tool use," *Ergonomics*, 10:48(7):807-20, 2005.

Sesto, M.E., Radwin, R.G., Block, W.F., and Best, T.M., "Upper limb dynamic responses to impulsive forces for selected assembly workers.," *J Occup Environ Hyg*. 3(2):72-9., 2006.\*

Radwin, R.G., Chourasia, A.O., Sesto, M.E., Upper limb mechanical changes following simulated repetitive power tool use. 16th World Congress of the International Ergonomics Association Meeting, Maastricht, The Netherlands, July, 2006.\*

### **New Proposal Funded:**

NIOSH, "Functional Limitations in Lateral Epicondylitis," Mary E. Sesto, PI, Funded, K01 OH008640-01.\*

### **Project #8**

Institution: The University of Wisconsin at Madison  
Faculty Sponsor: Robert G. Radwin, Ph.D.  
Research Student: Curtis Irwin (Ph.D. student, Biomedical Engineering)  
Title: Investigation of Handle Surfaces and Grasping Tasks  
NORA Area(s): Musculoskeletal Disorders  
Direct Cost Budget: \$18,835  
Funding Period: July 2001-June 2002

### **New Publication:**

Irwin, C. B. and Radwin, R. G., "A new method for estimating hand internal loads from external force measurements," Submitted.

### **Project #11**

Institution: Purdue University  
Core Area: Occupational Safety  
Faculty Sponsor: James McGlothlin, Ph.D.  
Research Scientist: Shirley Rietdyk, Ph.D., Assistant Professor, Department of Health and Kinesiology  
Title: Can Visual References Enhance Balance Control in the Occupational Environment in Both Younger and Older Construction Workers?  
NORA Area(s): Special Populations at Risk, Traumatic Injuries (falls)  
Direct Cost Budget: \$28,550  
Funding Period: July 2002-June 2003

### **New Publication:**

Rietdyk S, Torgerud SR, McGlothlin JD, Knezovich MJ. Stationary visual cues reduced centre of pressure displacement in a dynamic environment for experienced roofers. XXth Congress of the International Society of Biomechanics, Cleveland, Ohio, August 2005.

Torgerud SR, Rietdyk S & McGlothlin JD. Sensory re-weighting in postural control as a function of work experience in visually challenging environments. *Submitted to Experimental Brain Research, July 2006.\**

### **New funded proposal:**

Title: Interdisciplinary Airline Job Hazard Assessment  
Agency: Interdisciplinary Innovation Initiative, School of Technology, Purdue  
Duration of Funding: 05/01/2004 – 04/30/2005  
Role: Rietdyk, McClothlin, Co-PIs  
Goals: To assess airline job risk as a function of falls and carrying loads.

### **Project #12**

Institution: The University of Michigan  
Core Area: Industrial Hygiene  
Faculty Sponsor: Stuart Batterman, Ph.D.  
Research Trainee: Christopher Godwin, DDS, MPH, Ph.D. Student, Environmental Health Science)  
Title: Indoor air quality in public schools: an assessment of exposures and symptoms of teachers  
NORA Area(s): Exposure Assessment Methods, Indoor Environment, Special Populations at Risk  
Direct Cost Budget: \$33,000  
Funding Period: July 2002-June 2003

### **New Publications:**

Jia, Chunrong, Stuart A Batterman, Chris Godwin, "Levels and Sources of VOC Exposures in Microenvironments: A Monte Carlo Analysis", Philadelphia, PA,

International Society of Exposure Analysis Annual Meeting, October 17-21, 2004. (not previously reported)

Batterman, S, C Jia, C Godwin, G Hatzivasilis, "Distributions of Volatile Organic Compounds (VOCs) in Indoor and Outdoor Air among Industrial, Urban and Suburban Neighborhoods," presented at IAQ 05, Beijing, China, Sept. 4-9, 2005.

C. Godwin, S. Batterman, "Indoor Air Quality in Michigan Schools", *Indoor Air*, 17, 2, 109-121, 2007. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1600-0668.2006.00459.x>.\*

#### **Proposals Submitted/Funded:**

Dr. Batterman received support from the American Chemistry Council (6/1/03 – 5/30/06) for a project entitled "Understanding Exposure to Volatile Organic Air Toxics" in which Dr. Godwin plays a major role.

#### **Project #14**

Institution: The University of Michigan  
Core Area: Occupational Health Nursing  
Research Trainee: Janis M. Miller, Ph.D., R.N., Assistant Research Scientist, School of Nursing  
Title: The Differences in Female Levator Ani Muscle Function Between Occupational Lifters and Non-Lifters  
NORA Area(s): Special Populations at Risk, Musculoskeletal Disorders  
Direct Cost Budget: \$15,870  
Funding Period: June 2003-July 2004

#### **New position of trainee:**

Dr. Miller is an Assistant Research Scientist in the School of Nursing and a Research Assistant Professor Investigator in the OB/GYN Department of the School of Medicine at The University of Michigan.

#### **New funded proposals:**

The methodology developed in the pilot study entitled "The Differences in Female Levator Ani Muscle Function Between Occupational Lifters and Non-Lifters" is now being used in two funded NIH projects. Specifically, the one-billed instrumented speculum tested for usability and repeatability in the pilot study, is now one of the main instruments in use in Phase II of the Incontinence Research Intervention Study (P50 HD44406) and throughout the Evaluating Maternal Recovery from Labor and Delivery study (R 21 01-HD049818). Both of these NIH-funded projects are detailed below, and are the only studies to date, aside from the pilot, with data from this newly developed instrumented speculum. Each of these two NIH funded studies is also collecting questionnaire data on women's habits of lifting on a daily basis. On completion of these studies we will, for the first time to my knowledge, have obtained data on approximately 120 women that documents both amount of lifting typically taking place in the woman's life and a quantified score of pelvic floor strength as measured by the one-billed speculum.

NIH, 1 P50 HD44406

"Selection Criteria for Pelvic Muscle Therapy in SUI", an R01 study within the "University of Michigan Specialized Center of Research on Sex and Gender Factors Affecting Women's Health (SCOR)".

Janis Miller (PI)  
Sept. 1, 2002 – Aug. 31, 2007

NIH, R 21 01-HD049818-0 1  
“Maternal Birth-Related Neuromuscular Injury and Recovery”  
Janis Miller (PI)  
May 1, 2005 – April 31, 2007

**Project #15**

Institution: The University of Wisconsin  
Core Area: Occupational Safety and Ergonomics  
Faculty Sponsor: Robert G. Radwin, Ph.D.  
Research Trainee: Robert H. Meyer, Ph.D. Student, Dept. of Industrial Engineering  
Title: Comparison of back and neck fatigue in stoop versus prone postures while performing a simulated manual agricultural task  
NORA Area(s): Special Populations at Risk, Musculoskeletal Disorders  
Direct Cost Budget: \$19,981  
Funding Period: June 2003-July 2004

**New Publications:**

Meyer, R.H., and Radwin R. G., “Comparison of stoop versus prone postures for a simulated agricultural harvesting task,” *Applied Ergonomics*, In Press.

Meyer, R. H. and Radwin, R. G., Comparison of stoop versus prone postures for a simulated agricultural harvesting task, 16th World Congress of the International Ergonomics Association Meeting, Maastricht, The Netherlands, July, 2006.\*

Meyer, R. H. and Radwin, R. G., Strength limits and interventions for gas utility wrenching tasks, 16th World Congress of the International Ergonomics Association Meeting, Maastricht, The Netherlands, July, 2006.\*

**Project #16**

Institution: The University of Michigan  
Core Area: Industrial Hygiene  
Research Trainee: Peter Mancuso, Ph.D., Assistant Professor of Environmental Health Science  
Title: Alveolar macrophage responses to fine and ultrafine particles  
NORA Area(s): Asthma and Chronic Obstructive Pulmonary Disease, Exposure Assessment  
Direct Cost Budget: \$20,000  
Funding Period: June 2003-July 2004

**New Publication:**

J. Phipps, J. Curtis, P. Christensen, D. Aranoff, and P. Mancuso. Regular and low-tar mainstream cigarette smoke exposure attenuates murine pulmonary host defense against *Streptococcus pneumoniae*. 2006. *Proc. Am. Thoracic Soc* 3:A:806.\*

**New funded proposals:**

University of Michigan Tobacco Research Network  
Funding for a pre-doctoral fellow

Title: The effect of low tar cigarette exposure on pulmonary antibacterial host defense  
Date: 9/1/04-8/30/05  
Annual direct costs: \$40,000

**New unfunded proposals:**

NIH NIEHS P42 Superfund Grant with University of Tennessee  
Title: PAHs suppress pulmonary antibacterial host defense

**Project #18**

Institution: The University of Michigan  
Core Area: Occupational Epidemiology  
Faculty Sponsors: Alfred Franzblau, M.D., W. Monroe Keyserling, Ph.D.  
Research Trainee: Jennifer Chang D'Souza, Ph.D. Student, Occupational Epidemiology  
Title: Expert Ratings of NHANES Occupational Categories  
NORA Area(s): Musculoskeletal Disorders, Exposure Assessment  
Direct Cost Budget: \$17,257  
Funding Period: June 2004-July 2005

**Current Position of Research Trainee:**

Ms. D'Souza has completed her Ph.D. in Occupational Epidemiology and is currently working at the Institute of Gerontology, at the University of Michigan.

**New Publications:**

Jennifer C. D'Souza; Alfred Franzblau; W.Monroe Keyserling; Brenda Gillespie; Robert A. Werner. Occupational factors and Knee Osteoarthritis (OA): An analysis of the Third National Health and Nutrition Examination Survey (NHANES III) using Expert Ratings, 28<sup>th</sup> International Congress on Occupational Health, Milan, Italy, June 2006.\*

Jennifer C. D'Souza; Alfred Franzblau; W. Monroe Keyserling; Brenda Gillespie; Robert A. Werner. Expert consensus ratings of occupational physical exposures, 28<sup>th</sup> International Congress on Occupational Health, Milan, Italy, June 2006.\*

Jennifer C. D'Souza, Robert A. Werner, W. Monroe Keyserling, Brenda Gillespie, Randall Rabourn, Sheryl Ulin, Alfred Franzblau. Analysis of the Third National Health and Nutrition Examination Survey (NHANES III) using Expert Ratings of Job Categories, working paper to be submitted to AJIM.\*

Jennifer C. D'Souza, W. Monroe Keyserling, Robert A. Werner, Brenda Gillespie, Alfred Franzblau. Expert Consensus Ratings of Job Categories from the Third National Health and Nutrition Examination Survey (NHANES III), working paper to be submitted to AJIM.\*

**New proposals submitted/funded:**

Proposal to National Center of Health Statistics/ Research Data Center to release data on NHANES Subjects' specific job codes using 3-digit 1980 Census job codes. Proposal to release data accepted with no additional funding.

**Project #19**

Institution: The University of Wisconsin

Core Area: Safety and Ergonomics  
Faculty Sponsor: Robert G. Radwin, Ph.D.  
Research Trainee: Amrish Chourasia, Ph.D. Student, Biomedical Engineering  
Title: Comparison of biomechanical effects of eccentric and concentric exertions  
NORA Area(s): Musculoskeletal Disorders  
Direct Cost Budget: \$19,401  
Funding Period: June 2004-July 2005

**New Publications:**

Radwin, R.G., Chourasia, A.O., Sesto, M.E., Upper limb mechanical changes following simulated repetitive power tool use. 16th World Congress of the International Ergonomics Association Meeting, Maastricht, The Netherlands, July, 2006

**Project #20**

Institution: The University of Michigan  
Core Area: Industrial Hygiene  
Faculty Sponsor: Edward T Zellers, Ph.D.  
Research Trainee: Chunguang Jin, Ph.D. Student, Environmental Health Sciences  
Title: Chemometric Methods for Assessing Exposures to Indoor Air Contaminants with a Microanalytical System  
NORA Area(s): Indoor environments, Emerging technologies, Exposure assessment  
Direct Cost Budget: \$15,000  
Funding Period: June 2004-July 2005

**New Publications:**

Jin, C. and Zellers, E.T., "Pattern Recognition Techniques for VOC Detection by a Multi-sensor Array", Poster presentation, American Industrial Hygiene Conference & Exposure, Anaheim, May 2005.

Jin, C. and Zellers, E.T., "Artificial Neural Networks for a Multi-Sensor Micro-GC Detector", Poster presentation, Engineering Research Center for Wireless Integrated MicroSystems on-site meeting, Ann Arbor, May 2005.

Lu, C. J., Jin, C. and Zellers, E.T., "Chamber evaluation of a portable GC with tunable retention and microsensor-array detection for indoor air quality monitoring", *J. Environ. Monit.*, 2006, 8, 270-278.\*

Jin, C., Kursawski, P, Hierlemann, A., Zellers, E. T., "Performance Analysis of a Multi-Transducer Vapor Sensor Array", manuscript in preparation.\*

**New Proposals Submitted/Funded:**

Grant # 06-G-024  
Transportation Security Administration-Dept. Of Homeland Security  
E. Zellers, PI; C. Kurdak., co-I  
Au-Thiolate Nanoparticles as Interfacial Layers on Microsensor Arrays for Trace Explosive Vapor Detection\*  
09/29/06 – 09/28/09  
\$ 1,303,877 (TC)

**Project #21**

Institution: The University of Michigan  
Core Area: Occupational Health Nursing  
Research Trainee: Anne G. Thomas, Ph.D., Assistant Professor, Community Health Nursing  
Title: Worksite Intervention to Promote Physical Activity  
NORA Area(s): Special populations at risk, Intervention effectiveness research  
Direct Cost Budget: \$8,300  
Funding Period: June 2004-July 2005

**New publications:**

Thomas, Anne G. "University Worksite Intervention to Increase Physical Activity, Proceedings: Midwest Nursing Research Society 30th Annual Research Conference, Milwaukee, WI, April 2006.\*

Thomas, Anne G. "Increasing Physical Activity in an Academic Work Environment: Focus Group Results," Proceedings: Midwest Nursing Research Society 30th Annual Research Conference, Milwaukee, WI, April 2006.\*

Thomas, Anne G. "Increasing Physical Activity in an Academic Setting: An Intervention for Faculty and Staff," International Congress for Occupational Health, Milan, Italy, June 2006 (abstract accepted, but not presented).\*

**Project #22**

Institution: The University of Michigan  
Core Area: Ergonomics, Industrial Hygiene  
Faculty Sponsor: Thomas J. Armstrong, Ph.D.  
Research Trainee: Andrew Comai, Ph.D. Student, Environmental Health Sciences  
Title: Developing and testing guidelines for ergonomic assessment tools  
NORA Area(s): Musculoskeletal disorders, Exposure assessment methods  
Direct Cost Budget: \$20,000  
Funding Period: June 2004-July 2005

**Proposals Submitted/Funded:**

A followup grant proposal to follow up on these findings was submitted to Michigan Interdisciplinary Center on Social Inequalities, Mind and Body (MICOSIMB), but was not funded. The proposed work included resampling job risk factors at plants involved in the initial study and expanding the study to several more locations.

**Project #28**

Institution: The University of Michigan  
Core Area: Industrial Hygiene  
Research Trainee: Chuanwu Xi, Ph.D., Assistant Professor, Department of Environmental Health Sciences  
Title: Microbial Characterization of Metal Removal Fluids and Associated Biofilms Using Molecular Approaches  
NORA Area(s): Infectious Diseases, Indoor Environments, Exposure Assessment Methods, Asthma and Chronic Obstructive Pulmonary Disease  
Direct Cost Budget: \$15,400

Funding Period: July 2006-June 2007

**Abstract:**

Each year, billions of gallons of metal removal fluids (MRFs) are consumed in manufacturing for purposes such as metalworking (e.g., cooling and lubrication), surface preparation (e.g., cleaning and pickling), and finishing (e.g., coating and plating). A number of human health effects have been associated with exposure to MRFs, including various respiratory diseases, skin conditions, and cancers. It has become clear that the growth of microorganisms in MRFs may cause health hazards to workers. Several molecular techniques have been developed for the purpose of characterizing microorganisms in MRFs; however, no comprehensive study of microbial communities in MRFs has been reported yet. In this pilot project, we will develop and validate different molecular techniques for microbial characterization of MRFs samples. We will use the validated molecular methods to characterize microbial composition in detail in MRFs and to quantify the abundance of *Mycobacteria*, specifically *M. immunogenum* and *Pseudomonades* in MRFs environments including bulk fluids, biofilms and possibly bioaerosols to elucidate a possible critical role of biofilms in the microbial ecology in MRFs.

**Proposals Submitted/Funded:**

An R21 proposal focusing on a prospective study of biofilms and *Mycobacteria* in metalworking fluids was submitted to NIOSH in February, 2007 using the data collected in this pilot project as preliminary studies. A priority score of 201 was given by the review panel for this proposal and a resubmission is planned for the November, 2007 deadline. \*

**Papers in progress:**

Publications planned to submit to the American Industrial Hygiene Association Journal (AIHAJ):

Jianfeng Wu, Alfred Franzblau and Chuanwu Xi, Molecular characterization of Microbial Communities and Quantification of *Mycobacterium immunogenum* in Metalworking Fluids and its Associated Biofilms.\*

**Project #29**

Institution: The University of Michigan  
Core Area: Industrial Hygiene  
Research Trainee: Simone Charles, Ph.D., Post-doctoral Research Fellow,  
Department of Environmental Health Sciences  
Faculty Sponsor: Stuart Batterman, Ph.D., Professor, Department of Environmental  
Health Sciences  
Title: Post-doctoral Training in Exposure Assessment of Emerging  
Contaminants in the Indoor Environment  
NORA Area(s): Indoor Environments, Exposure Assessment Methods  
Direct Cost Budget: \$20,000  
Funding Period: July 2006-June 2007

**Abstract:**

Brominated flame retardants (BFRs) such as polybrominated diphenyl ethers (PBDEs) and biphenyl are widely used in plastics, textiles, foams and electronic equipment. These contaminants are of great concern as body burdens are increasing at an exponential rate in both occupationally-exposed workers and in the general public. The

emission sources and transport pathways that cause these exposures are poorly understood, particularly in the workplace. The available but limited measurements show that indoor concentrations of BFRs are high and greatly exceed outdoor levels. Because indoor and workplace environments are known to contain these materials, and since indoor levels appear to accumulate due to the presence of these sources and the slow rate of degradation, industrial and commercial buildings may represent an important exposure source. To date, however, the literature contains few occupational exposure studies that have characterized BFRs, and all of the identified studies have been conducted in Europe, though much higher exposures have been reported in North America. The proposed research aims to better understand occupational exposures of BFRs by characterizing their distribution and emissions in both commercial and industrial buildings. Emissions from indoor materials will be quantified by measuring vapor and particulate phase BFR-related compounds at 12 industrial and 12 commercial sites. At each site, we will measure incoming (outdoor) and exiting (indoor) BFR concentrations; determine air exchange rates using tracer gas techniques; assess building volume and other building parameters; and conduct a building walkthrough audit. Emission rates will be derived from the collected data by mass balance. Complementary but separate work will characterize these compounds in residential environments for comparison.

**Current Position of Research Trainee:**

In August, 2007, Dr. Charles was appointed as Assistant Professor of Environmental Health Sciences at the Jiann-Ping Hsu College of Public Health, Georgia Southern University in Statesboro, GA.

**New Publications**

S Chernyak, S Batterman, A Konoplev, A Kochetkov, C Godwin, C Jia, S Charles. "Fate of Brominated Flame Retardant Chemicals in Russian and US Buildings," SETAC Europe 17th Annual Meeting in Porto, May 20-24, 2007.\*

Chernyak SM, Batterman SA, Godwin CC, Jia C, Charles SM, Evolution of flame retardant chemicals in a newly constructed building (in preparation)\*

**Proposals submitted/funded:**

None

**Project #30**

Institution:	The University of Michigan
Core Area:	Occupational Safety and Ergonomics
Research Trainee:	NaJin Seo
Faculty Sponsor:	Thomas J. Armstrong, Ph.D., Professor, Department of Industrial and Operations Engineering
Title:	Development of a Biomechanical Model for Torque and Thrust Strength on Cylindrical Handles
NORA Area(s):	Musculoskeletal Disorders of the Upper Extremity, Traumatic Injuries
Direct Cost Budget:	\$19,360
Funding Period:	July 2006-June 2007

**Abstract:**

The aim of this work is to develop models for predicting the capacity of the hand to apply torque and thrust force about and along the long axis of cylindrical handles. More specifically, this work will develop a biomechanical model of isometric or "quasi isometric" torque and thrust force that can be exerted on cylindrical handles of a given diameter and surface friction when gripped at a given angle.

Our proposed biomechanical model and preliminary research show that torque strength about the long axis of a cylindrical handle is greater when torque is applied in the direction of the fingers than in the direction of the thumb. The proposed study will 1) validate the biomechanical model for various handle materials. It will also examine 2) the effect of torque on pushing and pulling along the long axis of the handle and 3) the effect of grip force on wrist flexion and extension strength. In addition, the coefficient of friction will be measured for different parts of the hand with different normal force levels and handle materials. The models developed in this study can be used to establish force design limits for work tasks that will accommodate desired percentiles of the male and female population. They also can be used to design equipment that minimizes force requirements, localized fatigue and the risk of work-related musculoskeletal disorders.

**Publications:**

Seo, N.J., Armstrong, T.J., Chaffin, D.B., Ashton-Miller, J.A.. Inward Torque and High Friction Handle Can Reduce Required Muscle Efforts for Torque Generation. *Human Factors*, 2008 Feb.\*

Seo, N.J., Armstrong, T.J., Chaffin, D.B., Ashton-Miller, J.A.. The Effect of Handle Friction and Inward/Outward Torque on Axial Push Force. *Human Factors*, Accepted.\*

## Appendix PPRT – 6. Summary of Funded Pilot Projects (1999-2007)

### Project #1

Institution: The University of Michigan  
Core Area: Occupational Safety and Ergonomics  
Faculty Sponsor: Thomas J. Armstrong, Ph.D.  
Research Student: Matthew Marshall, Ph.D. student, Industrial and Operations Engineering  
Title: Quantifying Forceful Manual Exertions in Industry  
NORA Area(s): Musculoskeletal Disorders  
Direct Cost Budget: \$12,225  
Funding Period: July 1999 – June 2000

### **Abstract:**

Forceful hand exertions are a recognized risk factor for the development of Work Related Musculoskeletal Disorders in the upper extremity. The need for measuring and quantifying hand force during manual exertions is widespread, but there currently are few user-friendly tools. This project will investigate, develop, and improve a hierarchical system of tools for measuring hand forces. First, the study will examine the use of electromyographic (EMG) techniques for estimating hand forces in dynamic work. The relationship between EMG calibration techniques and the EMG-force curve will be studied for non-isometric exertions. The goal is to determine which calibration technique produces the most accurate relationship between EMG signal parameters and the actual magnitude of the manual exertion. Second, the study will investigate the ability of workers and job analysts (observers) to subjectively discriminate among different levels of hand force. Finally, an observer-based force rating methodology will be developed and validated. This system will have applications in 1) basic ergonomic job analysis to assess risk factors for upper extremity MSDs, and 2) rehabilitation job analysis to accommodate the forceful demands of a job with an injured or disabled worker's ability to perform manual exertions. This system will use benchmarks of forceful exertions of varying magnitudes selected from common occupational and non-occupational work activities. A combination of laboratory experiments and field surveys will be used to achieve the research goals.

### **Current Position of Research Trainee:**

Assistant Professor, Industrial and Systems Engineering, Rochester Institute of Technology

### **Papers and Presentations:**

Marshall, M.M. and Armstrong, T.J. "Perceived force requirements for activities of daily living," XVth Triennial Congress of the International Ergonomics Association, Seoul, Korea, 2003

Marshall, M.M., Armstrong, T.J., and Ebersole, M.E., "Verbal estimation of peak exertion intensity," Human Factors, in press.

### **Proposals Submitted/Funded:**

"Factors Affecting Verbal Estimation of Peak Forceful Exertion," submitted to NIOSH R03 Program, not funded

### Project #2

Institution: The University of Michigan  
Core Area: Occupational Health Nursing  
Faculty Sponsor: Sally L. Lusk, Ph.D.  
Research Student: Oisaeng Hong, Post-Doctoral Fellow, Community Health Nursing  
Title: Noise Induced Hearing Loss and Hearing Protection in African-American Workers  
NORA Area(s): Hearing Loss and Special Populations at Risk  
Direct Cost Budget: \$12,667  
Funding Period: July 1999 – June 2000

**Abstract:**

Noise-induced hearing loss (NIHL) is an irreversible impairment cause significant monetary and personal costs. Because NIHL is irreversible, prevention is the most important means of reducing the prevalence of this condition. Consistent use of hearing protection devices (HPDs) reduces noise exposure and subsequent NIHL. Because workers do not consistently use HPDs, there is a need to identify the most effective ways to assist workers in adopting the use of HPDs. In particular, little attention has been directed toward describing the prevalence of hearing loss among African-American workers, their use of HPDs, and identifying the most effective way to assure proper use of HPDs.

This project will investigate the effectiveness of a tailored intervention program to increase the use of HPDs by African-American workers. Three specific aims will be addressed: 1) determining the prevalence of hearing loss in African-American factory workers, 2) identifying the most important predictors of African-American factory workers' use of HPDs, and 3) determining the effectiveness of hearing protection interventions for African-American factory workers to increase their use of HPDs.

The proposed project will use data from about 385 African-American workers in an ongoing intervention study of approximately 3,500 workers in a Midwestern automotive factory. The proposed study will assess a new training technology, an individually-tailored, interactive, multimedia program delivered by computer. This method builds on recent research findings regarding the effectiveness of individually-tailored interventions. Results will provide a model for future intervention research in occupational safety and health and aid in reducing NIHL.

**Current Position of Research Trainee:**

Assistant Professor, School of Nursing, The University of Michigan

**Papers and Presentations:**

Hong, O., Lusk, S.L., and Ronis, D.L. "Ethnicity differences in predictors for hearing protection behavior in Black and White workers," Research & Theory for Nursing Practice: An International Journal, in press.

Hong, O., Lusk, S.L., Ronis, D.L., and Brady, J.S. "Predictors of African-American factory workers' use of hearing protection," Midwestern Nursing Research Society 24<sup>th</sup> Annual Research Conference. Dearborn, MI, 2000

Hong, O., Lusk, S.L., Brady, J.S., and Ronis, D.L. "Prevalence and perception of hearing loss among African-American factory workers," American Public Health Association 128<sup>th</sup> Annual Conference, Boston, MA., 2000.

Hong, O., Lusk, S.L., and Ronis, D.L. "Racial difference in predictors of hearing protection behavior in African-American and white factory workers," National Institute of Nursing Research 15<sup>th</sup> Anniversary Symposium: Advancing health through science: Building knowledge for patient care. Bethesda, MD, 2001

**Proposals Submitted/Funded:**

NIOSH "Effectiveness of computer-based hearing test & training," funded, 5R01 OH04034-010A

Project #3

Institution: The University of Wisconsin at Madison  
Core Area: Occupational Safety and Ergonomics  
Faculty Sponsor: Robert G. Radwin, Ph.D.  
Research Student: Jia-Hua Lin, Ph.D. student, Industrial Engineering  
Title: A Biomechanical Model of Ergonomic Design and Selection of Hand Tools  
NORA Area(s): Musculoskeletal Disorders  
Direct Cost Budget: \$12, 944  
Funding Period: July 1999 – June 2000

**Abstract:**

This study develops a biomechanical model to predict the capacity for a human operator to react against the impulsive reaction force produced by power nutrunners. The human operator will be represented as a single-degree-of-freedom mechanical system that contains mass, spring, and damping elements. It is hypothesized that these parameters are dependent upon the operator's posture, the tool's shape, and the tool's orientation. An apparatus will be constructed to deliver an impulse that is similar to actual power tool operation. Five different handles and load conditions will be tested. Subjects will hold a handle while the resulting handle displacement to the impulse is recorded. The stiffness, mass, and damping elements corresponding to a specific work location and orientation is determined from the displacement by calculating frequency and amplitude changes. A computer program will be developed to estimate the hand force and hand displacement from this biomechanical model. The model will be validated in laboratory and field experiments using actual tools. The research team has already successfully conducted pilot tests for pistol grip nutrunners used on a vertical surface to demonstrate that the proposed method is feasible. The enhanced model will add knowledge about the operator response and result in better tools and workstations, reducing the physical strain experienced by power tool operators.

**Current Position of Research Trainee:**

Staff Scientist, Liberty Mutual Center for Safety Research

**Papers and Presentations:**

Lin, J.H., Radwin, R.G., and Richard, T.G., "Development and Validation of a Dynamic Biomechanical Model for Power Hand Tool Torque Build-up Reaction Force," Proceedings of the Human Factors and Ergonomics Society 44th Annual Meeting, San Diego, California, Vol. 5, pp. 29-32, July, 2000.

Radwin, R. G, Lin, J.H., and Richard, T., "A biodynamic model of human reaction to impulsive torques encountered in hand tools," World Congress on Medical Physics and Biomedical Engineering, Chicago, July, 2000.

Lin, J. H., Radwin, R. G., and Richard, T. G., "A dynamic model of the hand and arm in pistol grip power hand tool usage," Ergonomics, 44(3), 2001.

Lin, J. H, Radwin, R.G., and Richard, T.G., "Handle dynamics predictions for selected power hand tool applications," Human Factors, 45(4), 645-656, 2003.

Lin, J. H, Radwin, R.G., and Richard, T.G., "A single-degree-of-freedom dynamic model predicts the range of human responses to impulsive forces produced by power hand tools," Journal of Biomechanics, 36(12), 1845-1852, 2003.

Lin, J. H., Radwin, R.G., Fronczak, F.J., and Richard, T.G., "Forces associated with pneumatic power screwdriver operation: statics and dynamics," Ergonomics, 46 (12) 1161 – 1177, 2003.

Radwin, R. G., "Ergonomically-designed hand tools," American Industrial Hygiene Conference and Exposition, May, 2003.

Radwin, R. G., "Dynamic Loading of the Upper Limb in Industrial Work," 2003 State-of-the-Art Research (STAR) Symposium: Perspectives on Musculoskeletal Disorder Causation and Control, Columbus, OH, May, 2003.

**Proposals Submitted/Funded:**

UAW/GM Center for Human Resources, "Ergonomics Criteria for Industrial Power Hand Tools," (R.G. Radwin, Principal Investigator), Funded

**Project #4**

Institution:	The University of Wisconsin at Madison
Core Area:	Occupational Safety and Ergonomics
Faculty Scientist:	Nicola J. Ferrier, Ph.D., Assistant Prof. of Mechanical Engineering (junior faculty)
Title:	Visual Tracking for the Analysis and Measurement of Human Motion During
	Repetitive Tasks
NORA Area(s):	Musculoskeletal Disorders
Direct Cost Budget:	\$13,530
Funding Period:	July 1999 – June 2000

**Abstract:**

The ultimate goal of this project is to develop an automated system to identify and measure human position and motion during the execution of repetitive tasks. In assessing industrial hazards, human motion is often recorded on videotape. In evaluating the degree of repetition for assessing work-related risk, trained human observers view the video and score the repetitiveness of the task. This project aims to replace the human observers with a computer vision system. In other fields, such as traffic surveillance, human analysis of videotapes has been replaced with automated video analysis. Automated analysis and classification of human motion during repetitive tasks has not been successfully demonstrated, yet preliminary work in analysis of human

activity suggests that automatic measurement of human motion is feasible. This project will concentrate on the measurement of hand and upper limb motion. Experiments will be performed to demonstrate feasibility and validate the system by comparing measured results to previously-studied motion data obtained using conventional methods. Successful completion of the project will produce the means to automatically analyze videos of humans performing tasks and produce quantitative data to determine whether injury risk exists, and if so, which tasks or sub-tasks may require further analysis or intervention. Such a system would provide a robust, repeatable measurement of repetition that is not subject to human subjectivity, fatigue or other difficulties.

**Current Position of Research Trainee:**

Associate Professor, Mechanical Engineering, The University of Wisconsin

**Papers and Presentations:**

Lu, C. and Ferrier, N.J. "Automated Analysis of Repetitive Joint Motion," IEEE Trans. on Information Technology in Biomedicine, Vol 7, No. 4, pp. 256-263, Dec. 2003.

Lu, C. and Ferrier, N.J. "Repetitive Motion Analysis: Segmentation, Identification, and Event Detection," IEEE Trans. on Pattern Recognition and Machine Intelligence, 26:2 pp 258-264, 2004.

Lu, C. and Ferrier, N.J., "A Digital Video System for the Automated Measurement of Repetitive Joint Motion," IEEE Trans. on Information Technology in Biomedicine in press.

**Proposals Submitted/Funded:**

Video-based Measurement and Analysis of Human Motion during Repetitive Tasks, submitted to NIOSH R03 Program, not funded

**Project #5**

Institution:	The University of Michigan
Core Area:	Occupational Safety and Ergonomics
Faculty Sponsor:	Thomas J. Armstrong, Ph.D.
Research Student:	Christian Grieshaber, Ph.D. student, Industrial and Operations Engineering
Title:	A Biomechanical Model of the Hand and Wrist
NORA Area(s):	Musculoskeletal Disorders
Direct Cost Budget:	\$14,595
Funding Period:	July 2000 – June 2001

**Abstract:**

Evaluating posture and assessing the force required to perform a manual task is a significant aspect of studying the biomechanical and epidemiological aspects of upper extremity cumulative trauma disorders (UECTDs). Biomechanical and kinematic modeling are methods that can be used to predict postural and strength capabilities for a given set of task-related constraints. These models will aid in proactively describing stressful or potentially stressful tasks and work situations. This study was undertaken to verify a kinematic model of the hand, and to evaluate intra-subject variability in power grasp posture. Joint angle measurements of the MCP, PIP, and DIP of the second phalange were from nine subjects (six males, three females) were recorded using motion tracking techniques. An NEC, TI-23A CCD camera was used to receive infrared light reflections from markers that were placed on the MCP, PIP, and DIP joints, and the

tip of the distal phalanx of the second phalange. A cylindrical dynamometer was used as the grasping object. The cylinder was elliptically shaped and had a long axis diameter of 4.5 cm, and a short axis diameter of 3.2 cm.

27 angle measurements were compared to the model predictions for each joint. For 25 of the 27 joints measured, the model predicted hyperflexion of the respective joint. For the MCP joint, the mean difference between actual and predicted was -20.5 degrees (hyperflexion), with a standard error of 1.8. For the PIP and DIP, the mean and standard error were -11.5 (3.9) degrees and -8.9 (4.2) degrees, respectively. The mean standard deviations for all subjects were relatively small at 1.11 for the MCP joint, 1.99 for the PIP joint, and 5.34 for the DIP joint. Individual standard deviations ranged from a low of 0.00 to a high of 5.09 degrees. This was measured over ten trials for each subject. The location of the object in the hand significantly affected the model prediction angles.

The current model was able to predict gross postures of the hand in power grasp with reasonable accuracy and precision. This study is the first step in developing a model capable of evaluating the postural and biomechanical aspects of grasping work objects. Future research will focus on developing research and algorithms to accurately predict how people grasp objects of varying geometry. Special attention needs to be given to algorithms for placing the object in the hand, quantifying skin deformation as a measure of the force of gripping and predicting contact between the hand and non-cylindrically shaped objects.

**Current Position of Research Trainee:**

Mr. Grieshaber is a Ph.D. Candidate in Industrial and Operations Engineering at The University of Michigan. He is completing a dissertation titled A Model for Predicting Posture of the Human Hand and its Prehensile Strength Capabilities and expects to defend in late 2004 or early 2005.

**Papers and Presentations:**

Grieshaber D.C. and Armstrong, T.A. "Systematic Characterization of Gross Hand Postures Employed During Actual Work Tasks," XVth Triennial Congress of the International Ergonomics Association, Seoul, Korea, 2003

Grieshaber D.C. and Armstrong, T.A. "Characterization of Hand Postures Employed by Industrial Workers During Hose Installation Tasks," accepted for presentation at the Human Factors and Ergonomics Society 48<sup>th</sup> Annual Meeting, New Orleans, September 2004.

**Proposals Submitted/Funded:**

None at this time.

**Project #6**

Institution:	The University of Michigan
Core Area:	Industrial Hygiene
Faculty Sponsor:	Edward T. Zellers, Ph.D.
Research Student:	Meng-Da Hsieh, Ph.D. Student, Environmental Health Sciences
Title:	Testing the Performance of a Novel Vapor Monitoring Instrument
NORA Area(s):	Exposure Assessment
Direct Cost Budget:	\$17,120

Funding Period: July 2000-June 2001

**Abstract:**

Laboratory testing and performance modeling of a novel, personal direct-reading instrument capable of identifying and quantifying organic vapors at low-ppm concentrations was performed. Marketed under the name VaporLab<sup>®</sup>, this instrument was designed as a “vapor comparator”. The tested instrument weighs less than 1.5 lbs and is about the size of a standard personal sampling pump. It employs an array of four polymer-coated surface-acoustic-wave (SAW) microsensors and a miniature pre-concentrator for vapor detection. The patterns of responses obtained from the array are used to identify specific vapors or vapor mixtures and can be used to discriminate among the components of certain simple mixtures.

Following some modifications to the instrument and initial laboratory calibrations, side-by-side measurements with standard methods were performed in dynamic controlled test-atmospheres. Results demonstrated the capability for direct analysis of certain vapors and vapor mixtures at concentrations relevant to occupational exposure and compliance monitoring applications. In conjunction with the work just described, in-house pattern recognition software routines coupled with Monte Carlo simulations were used to define generalized performance limits/capabilities of the instrument.

Current personal monitoring instrumentation cannot provide selective analysis of multiple organic vapors. This research has shown that the new instrument is capable of providing improved personal exposure data needed for characterizing the distributions of organic-vapor exposures in the workplace and determining compliance with accepted exposure limits. This research has addressed on-going needs identified in the NIOSH National Occupational Research Agenda (NORA) in the areas of emerging technologies and exposure assessment methods.

**Current Position of Research Trainee:**

Mr. Hsieh earned his Ph.D. degree in August, 2003 and is currently employed as a corporate industrial hygienist at Abbott Laboratories, North Chicago, IL.

**Papers and Presentations:**

Hsieh, M. and Zellers, E.T. “Personal Vapor Monitor for Recognizing, Differentiating, and Quantifying Multiple Organic Vapors,” The Federation of Analytical Chemistry and Spectroscopy Societies (FACSS) Annual Meeting, Detroit, October, 2001.

Hsieh, M. and Zellers, E.T. “Evaluation of a Commercial Belt-Mounted Multi-Vapor Monitoring Instrument”, American Industrial Hygiene Conference and Exposition, San Diego, CA, 2002.

Hsieh, M. and Zellers, E.T. “Adaptation and evaluation of a hand-held ‘electronic nose’ for selective multi-vapor analysis,” *J. Occup. and Environ. Hyg.* 1:149-160, 2004

**Proposals Submitted/Funded:**

No direct follow-on funding was sought on the basis of the results of this project. However, the project had an indirect impact on submission of (and successful funding of) a competing renewal of the following related NIOSH R01 Grant:

NIOSH, “Microanalytical System for Indoor VOC Monitoring,” E.T. Zellers (PI), R01-OH03692-01, 4/1/02-3/31/05.

### **Project #7**

Institution: The University of Wisconsin at Madison  
Core Area: Occupational Safety and Ergonomics  
Faculty Sponsor: Robert G. Radwin, Ph.D.  
Research Student: Mary Sesto, Ph.D. student, Industrial Engineering)  
Title: The Effects of Eccentric Contractions on Muscle Mechanical Properties  
NORA Area(s): Musculoskeletal Disorders  
Direct Cost Budget: \$16,300  
Funding Period: July 2000-June 2001

### **Abstract:**

This study investigated changes in human muscle mechanical properties due to eccentric activities, similar to exertions associated with operation of impulsive vibrating hand tools. Specifically, the study tested the hypothesis that mechanical changes following eccentric muscle contractions endure longer than changes associated with static muscle exertions.

Eighteen subjects (9 male, 9 female) were randomly assigned to one of three treatments in a laboratory study. Six performed static isometric exertions, six performed eccentric exertions, and six served as controls. All subjects were tested using an apparatus designed to measure mechanical properties of muscles, including stiffness and mass moment inertia. Forearm supination strength was also measured. Subjects were tested prior to a bout of exercise, immediately following exercise, and 24 hours later.

Forearm supination strength decreased 19% immediately post-exercise and 7% after 24 hours in the isometric exercise group, compared to 34% post-exercise and 14% after 24 hours in the eccentric exercise group ( $p < .001$ ). The percent change in stiffness from pre-exercise to post-exercise in the isometric exercise and control groups was less than 1%, compared to an 11% decrease in stiffness in the eccentric exercise group ( $p < .01$ ). After 24 hours, the change in stiffness in the isometric and control groups stayed below 1%, compared to an 8% decrease in the eccentric exercise group. There was also a post-exercise decrease in mass moment inertia in the eccentric group compared to the control and isometric exercise groups ( $p < .01$ ).

The consequences of reduction in stiffness and mass moment inertia following eccentric exertions include reduced capacity to react against torque reaction forces when operating power hand tools. This reduction in capacity may have adverse long-term effects on safety. Future research will investigate the magnitude of mechanical changes for different levels of eccentric exertions and different dynamic velocities.

### **Current Position of Research Trainee:**

Dr. Sesto is an Assistant Scientist, University of Wisconsin-Madison, Department of Biomedical Engineering and Trace Center.

### **Papers and Presentations:**

Sesto, M.E., Radwin, R.G., Block, W.F., and Best, T.M., "Upper Limb Dynamic Mechanical and Anatomical Properties Among Assembly Operators," Human Factors and Ergonomics Society 47<sup>th</sup> Annual Meeting, Denver, CO, October, 2003.

Radwin, R.G. Sesto, M.E., Richard, T.G., "Short-term Changes in Upper Extremity Dynamic Mechanical Properties Associated with Power Hand Tool Use, Human Factors and Ergonomics Society 47<sup>th</sup> Annual Meeting, Denver, CO, October, 2003.

Radwin, R.G., "Dynamic Loading of the Upper Limb in Industrial Work," 2003 State-of-the-Art Research (STAR) Symposium: Perspectives on Musculoskeletal Disorder Causation and Control, Columbus, OH, May, 2003.

Sesto, M.E., Radwin, R.G., Best, T.M., and Richard, T.G., "Upper limb mechanical changes following short duration repetitive eccentric exertions," submitted to Clinical Biomechanics.

Sesto, M.E., Radwin, R.G., Block, W.F., and Best, T.M., "Anatomical and Mechanical Changes Following Repetitive Eccentric Exertions," submitted to Clinical Biomechanics.

Sesto, M.E., Radwin, R.G., Block, W.F., and Best, T.M., "Assembly Worker Upper Limb Dynamic Mechanical Properties," in preparation.

**Proposals Submitted/Funded:**

NIOSH, "Biomechanical Effects of Industrial Eccentric Exertions," Robert G. Radwin, PI, Funded, 1R01 OH07793

**Project #8**

Institution: The University of Wisconsin at Madison  
Faculty Sponsor: Robert G. Radwin, Ph.D.  
Research Student: Curtis Irwin (Ph.D. student, Biomedical Engineering)  
Title: Investigation of Handle Surfaces and Grasping Tasks  
NORA Area(s): Musculoskeletal Disorders  
Direct Cost Budget: \$18,835  
Funding Period: July 2001-June 2002

**Abstract:**

A new dynamometer was designed to investigate the effects of handle shape and size on sub-maximal grip force in order to understand how to design handles that maximize grip force and minimize effort. This is particularly important for designing industrial hand tools and equipment to reduce the risk of musculoskeletal disorders. The new dynamometer will quantify the effects of different handle geometries on the resultant force vector generated during gripping. This is done by obtaining both force magnitude and direction in two orthogonal axes during a single squeeze. This device will also permit users to change the shape and size of different handles in width and breadth. A biomechanical model will estimate finger tension for each condition. The results will enable us to determine the handle dimensions resulting in the greatest force and the least stress in the hands.

Twelve subjects (6 males and 6 females) performed simple load transfer and twisting tasks using bare aluminum handles or ones covered with a high-friction material. The tasks were one under dry and oil-saturated conditions at three different load levels (weight). Grip force was measured via strain gauges mounted in the handles. Analysis of various showed that all three independent variables were significant ( $p < .001$ ).

**Current Position of Research Trainee:**

Mr. Irwin is a Graduate Student Research Assistant, Department of Biomedical Engineering, University of Wisconsin-Madison

**Papers and Presentations:**

Irwin, C. B. and Radwin, R. G., "A New Method for Estimating Biomechanical Loading in Grip," Human Factors and Ergonomics Society 47<sup>th</sup> Annual Meeting, Denver, CO, October, 2003.

**Proposals Submitted/Funded:**

None.

**Project #9**

Institution: The University of Michigan  
Core Area: Occupational Safety (Traumatic Injury)  
Research Trainee: Samuel A. McLean, M.D., M.P.H (Lecturer, Dept. of Emergency Med.)  
Title: Occupational Injuries Presenting to the Emergency Department: Workplace Conditions and Functional, Economic and Social Consequences  
NORA Area(s): Traumatic Injury, Health Services Research, Social and Economic Consequences  
Direct Cost Budget: \$18,730  
Funding Period: July 2001-June 2002

**Abstract:**

The National Occupational Research Agenda has identified traumatic injury, health services research, the social and economic consequences of workplace illness and injury, and surveillance research methods as priority areas. Approximately 34% of occupational injuries are treated in the ED, with estimates of 10.5 million occupational injuries treated in EDs annually. About 2% of occupational injuries treated in the ED are hospitalized; the rest are treated and released. Among patients presenting to the emergency department with workplace injury, little is known about workplace conditions surrounding the injury or patient outcomes. We plan to evaluate the causes and general health outcomes of workplace injury in patients presenting to the ED who are treated and released. A research assistant will approach patients presenting to the emergency department with an occupational injury for enrollment into the study cohort. Baseline patient characteristics, including demographic information, employer information, type and mechanism of injury, and pre-injury health status will be collected on consenting patients. Telephone surveys will be administered to individuals 5-7 days after the ED visit to assess work and general health consequences. Those indicating ongoing adverse injury consequences will be screened again two weeks and six weeks after the ED visit. Working conditions, demographic and injury information, task-specific job loss, days of work lost, and general health outcomes will be assessed. This information will be used to implement future intervention studies aimed at preventing occupational injury or limiting the associated morbidity through ED interventions.

**Current Position of Research Trainee:**

Dr. McLean is a Lecturer in the Department of Emergency Medicine, University of Michigan Medical Center.

**Papers and Presentations:**

McLean, SA, Blow, FC, Walton, MA, Gregor, MA, Barry, KL, Maio, RF, Knutzen, SR.  
"Rates of at-risk drinking among patients presenting to the emergency department with occupational and non-occupational injury," Acad Emerg Med., 10: 1354-61, 2003.

**Proposals Submitted/Funded:**

"Development of Chronic Pain After Motor Vehicle Trauma," S.A. McLean PI, K12, Funded

**Project #10**

Institution: Wayne State University  
Core Area: Occupational Medicine  
Research Trainee: Cathy L. Simpson, M.D., M.P.H. (Assist. Professor, Dept. of Family Medicine)  
Title: Physical Activity and Disability in Hospital Workers  
NORA Area(s): Musculoskeletal Disorders, Back Pain  
Direct Cost Budget: \$19,148  
Funding Period: July 2001-June 2002

**Abstract:**

The importance of level of physical activity, an important health-related behavior, of individual workers on work-related musculoskeletal disorders (WRMSDs) has not been fully investigated. Previous studies that have investigated the influence of physical activity have either looked at its effect on the incidence of work-related injury or on the effect of exercise in limiting disability. These studies have not assessed the effect of a worker's usual level of leisure and occupational physical activity before the time of injury occurrence, on disability. The purpose of this pilot study is to develop a method for obtaining information about the habitual physical activity of hospital workers at the time of injury and during injury recovery. The one-year study will be conducted on a sample of 50 injured hospital workers recruited from the Detroit Medical Center Northwest Region Occupational Health Service (OHS) located at Sinai-Grace Hospital, Detroit, Michigan. The Northwest Region employs about 2000 workers, predominantly women and 50% African American. The OHS evaluates approximately 240 work-related injuries per year. Dr. Simpson (PI) has been the medical director of this clinic for six years and is actively involved in evaluation of worker injury. Subjects reporting a low back or upper extremity work-related injury will be recruited during their visit in the OHS. We will measure their leisure time and occupational physical activity by self-administered questionnaire using instruments previously validated. We will measure functional disability at baseline and at the time returned to work without restrictions. During the period of recovery, subjects will fill out a daily activity log and report their pain intensity. Subjects will be trained in the use of pedometers to measure physical activity from walking. Energy expenditure estimated from the occupational physical activity questionnaire will be compared to that estimated from direct observation of work. The jobs of 10 subjects who have returned to work without restriction will be directly observed and their jobs videotaped. The primary statistical analyses will be to look at the effect of energy expenditure on return to work without restrictions and correlate energy expenditure as measured by self-report with that measured by direct observation.

**Current Position of Research Trainee:**

Unknown.

**Papers and Presentations:**

None.

**Proposals Submitted/Funded:**

None.

**Project #11**

Institution: Purdue University  
Core Area: Occupational Safety  
Faculty Sponsor: James McGlothlin, Ph.D.  
Research Scientist: Shirley Rietdyk, Ph.D., Assistant Professor, Department of Health and Kinesiology  
Title: Can Visual References Enhance Balance Control in the Occupational Environment in Both Younger and Older Construction Workers?  
NORA Area(s): Special Populations at Risk, Traumatic Injuries (falls)  
Direct Cost Budget: \$28,550  
Funding Period: July 2002-June 2003

**Abstract:**

A worker's postural stability can be compromised by many influences, including the dynamic visual field within the work environment and the age of the worker. The proposed project draws on fundamental balance research and applies it to a worker population within the laboratory. This project will determine if a stable visual reference within a dynamic visual environment enhances balance control, and further, if postural stability enhanced in both younger and older workers. Also, the project will compare construction workers to non-construction workers, which is relevant to the introduction of new workers to the construction site, particularly when the new worker is older. The goal is to better understand workers' postural stability to address the following NORA priorities: 1) traumatic injury, and 2) special populations at risk. The results have potential use in preventing fatalities in industries involving a risk of falling. This project will lead to future research that includes a systematic analysis of potential factors which compromise stability at the worksite, and the potential mitigation of those factors through environmental changes.

**Current Position of Research Trainee:**

Dr. Rietdyk is an Assistant Professor of Biomechanics in the Department of Health and Kinesiology at Purdue University. Dr. Rietdyk also employed two M.S. students, Mr. Steve Torgerud, and Mr. Mark Knezovich, who are completed their degrees.

**Papers and Presentations:**

Torgerud SR, Rietdyk S, McGlothlin JD and Knezovich MJ. "Quiet standing and stability limits: effect of work experience and age," 28th Annual Meeting of the American Society of Biomechanics, Portland, OR, September 2004.)

**Proposals Submitted/Funded:**

None.

**Project #12**

Institution: The University of Michigan  
Core Area: Industrial Hygiene  
Faculty Sponsor: Stuart Batterman, Ph.D.

Research Trainee: Christopher Godwin, DDS, MPH, Ph.D. Student, Environmental Health Science)  
Title: Indoor air quality in public schools: an assessment of exposures and symptoms of teachers  
NORA Area(s): Exposure Assessment Methods, Indoor Environment, Special Populations at Risk  
Direct Cost Budget: \$33,000  
Funding Period: July 2002-June 2003

**Abstract:**

The nation's largest public workforce is the over 3 million teachers and staff working in elementary, middle and high schools. Despite growing health concerns among teachers, evidence that building systems critical to the indoor environment have significant defects in approximately half of schools, and the presence of many factors that may exacerbate indoor air quality (IAQ) problems in schools, there is a paucity of research that provides a systematic assessment of air quality and worker health and comfort in schools. The aim of the proposed pilot project is to provide research training to a post-doctoral scientist in the context of a crosscutting and multidisciplinary study that addresses the school environment. The study will address several hypotheses: (1) relative significance of pollutant exposures in schools vis-à-vis total exposures; (2) variability of concentrations within schools versus across schools; (3) linkage of pollutant concentrations, source activities, building condition, and ventilation system design and functioning; and (4) relationship of school staff health and comfort with the indoor environment.

To conduct this research, a variety of standards and innovative assessment techniques will be utilized, including area and personal monitoring of IAQ pollutants and comfort variables, and self-administered questionnaires that collect personal information, medical history, psychosocial factors, and a core set of symptoms and environmental factors in the workplace. 15 schools and 5 rooms/teachers in each school will be studied for a 1-week period. The analysis will be repeated in 10 schools in a different season giving a total sample size of 125. By partnering with the local school district, we will be able to monitor a wide range of parameters, including volatile organic compounds, PM<sub>2.5</sub> (particulate matter  $\leq 2.5 \mu\text{m}$ ), bioaerosols, dust, antigens, fibers, etc. Statistic analyses (correlations, factor analysis, ANOVAs, regression, etc.) will be used to address specific research questions. Results will be utilized to develop manuscripts for submission to key journals, and will be communicated to representatives of the local school advisory committee. This research is innovative in using a comprehensive questionnaire and activity log; employing simultaneous monitoring in multiple rooms to assess spatial and temporal variability as well as emission sources; apportioning exposures to work and non-work related periods, and in developing a high quality database suitable for epidemiological investigations of SBS-type symptoms. Further, the research will provide advanced training to a Ph.D./post-doctoral trainee that will represent significant extensions to his earlier research and skill level.

**Current Position of Research Trainee:**

Dr. Godwin has completed his Ph.D. and is a Research Associate in the Department of Environmental Health Science, School of Public Health, at The University of Michigan.

**Papers and Presentations:**

Batterman, SB, Godwin, C, Franzblau, A, Jia, C, Ellendula, S, Corsi, R, Torres, V, Sanders, M. "IAQ and Ventilation in Michigan and Texas Schools," 13th Conference of the International Society of Exposure Analysis (ISEA); Sept. 21-25, 2003, Stresa, Italy.

Batterman, S, Yu, Y, Jia, C, Godwin, C. "In-Use Evaporative Emissions from Vehicle Fuel Caps," presented at the Air & Waste Management Association Conference, Indianapolis, IN June 2004.

Jia, C, Godwin, C, Stuart A. Batterman, S, Franzblau, A. "Sources and Significance of VOC Exposures in Three Microenvironments: Schools, Residences and Vehicles," presented at the Air & Waste Management Association Conference, Indianapolis, IN June 2004.

**Proposals Submitted/Funded:**

Dr. Batterman is currently preparing a proposal titled "Diesel Exhaust Exposure and Aggravation of Childhood Asthma"

**Project #13**

Institution: The University of Michigan  
Core Area: Occupational Safety and Ergonomics  
Faculty Sponsor: Thomas Armstrong, Ph.D.  
Research Trainee: Kristin Streilein, M.S.E., Ph.D. Student, Biomedical Engineering  
Title: Observational Assessment of Ergonomic Stressors: Training Via the Web  
NORA Area(s): Musculoskeletal Disorders, Special Populations at Risk, Exposure Assessment Methods  
Direct Cost Budget: \$27,839  
Funding Period: June 2002-July 2003

**Abstract:**

Observational methods are widely used to assess ergonomic stresses and barriers to work. This study examines the consistency of such ratings both within and between raters. Secondly, it examines how rating consistency changes with increasing numbers of rating experiences. Thirdly, it examines the use of web-based video examples to accelerate and improve rating consistency and the influence of feedback during the learning process. The project will lead to quantitative criteria for determining when a rater is adequately "trained" in ergonomic job assessment methods. It will also provide guidance for the design and use of web-based resources for internet-based training. The results of this study will provide methods, criteria, and power calculations for future experiments in the area of assessment accuracy and precision in ergonomic job analysis.

**Current Position of Research Trainee:**

Ms. Streilein is presently finishing her Ph.D. Dissertation in the Department of Biomedical Engineering at The University of Michigan

**Papers and Presentations:**

None.

**Proposals Submitted/Funded:**

None.

**Project #14**

Institution: The University of Michigan  
Core Area: Occupational Health Nursing  
Research Trainee: Janis M. Miller, Ph.D., R.N., Assistant Research Scientist, School of Nursing  
Title: The Differences in Female Levator Ani Muscle Function Between Occupational Lifters and Non-Lifters  
NORA Area(s): Special Populations at Risk, Musculoskeletal Disorders  
Direct Cost Budget: \$15,870  
Funding Period: June 2003-July 2004

**Abstract:**

This study aims to investigate the influence of the presence or absence of a history of occupational stress (such as heavy lifting) on levator ani muscle (LA) function in women. The LA is primarily a pelvic postural muscle, responsible for carrying the load imposed by the pelvic contents in the human upright stature. Weak or damaged LA muscle is associated with the common pelvic floor disorders of prolapse or incontinence. Repetitive loading, as in occupational heavy lifting, may induce conformational changes to the LA. This area of investigation is unexplored in the literature. We will plan to recruit 12 occupational lifters and 12 non-lifters, age and race-matched, all without prior childbirth. An array of tests will be conducted to test LA function using new instrumentation developed at the University of Michigan and recently patented. Comparisons will be made using standard statistics: student's t-test and logistic regression. The primary outcome of the study is feasibility testing and power analysis calculations for a planned R01 submission to study influence of lifting on LA health while controlling for childbirth. The long-term goal of this line of research is to determine life style risk factors that predict development of pelvic floor disorders across age. Ultimately, the goal is to reduce the statistic of 1 in 10 women undergoing surgery for these disorders.

**Current Position of Research Trainee:**

Dr. Miller is an Assistant Research Scientist in the School of Nursing and a Research Investigator in the OB/GYN Department at The University of Michigan

**Papers and Presentations:**

None.

**Proposals Submitted/Funded:**

None.

**Project #15**

Institution: The University of Wisconsin  
Core Area: Occupational Safety and Ergonomics  
Faculty Sponsor: Robert G. Radwin, Ph.D.  
Research Trainee: Robert H. Meyer, Ph.D. Student, Dept. of Industrial Engineering  
Title: Comparison of back and neck fatigue in stoop versus prone postures while performing a simulated manual agricultural task  
NORA Area(s): Special Populations at Risk, Musculoskeletal Disorders  
Direct Cost Budget: \$19,981  
Funding Period: June 2003-July 2004

**Abstract:**

This research aims to develop a laboratory experiment to study a simulated agricultural task normally performed bent over while working at ground level and alternatively working on a prone support platform. These two methods will be compared by quantifying the biomechanical (localized muscle fatigue), perceived discomfort and performance effects of the stoop and prone postures. Prior research for prone workstation technology adoption has focused mainly on productivity and economic payback rather than on the effect of working in a prone posture on the body. This study investigates if the prone posture is effective in delaying the onset of fatigue while maintaining performance. This experiment will utilize surface EMG to characterize localized fatigue in the upper back and neck muscles, as well as a psychophysical scale to determine the perceived exertion of the subjects while performing a motion intensive task using the hands, similar to hand harvesting in agriculture. Should this research prove a delay in onset of fatigue in the upper back and neck, further research could encompass whole body fatigue analysis. This research is a pilot study for further investigation into workstations in agricultural ergonomics and their potential to reduce fatigue and musculoskeletal disorders in manufacturing and rehabilitation settings.

**Current Position of Research Trainee:**

Mr. Meyer is currently a Graduate Student Research Assistant working toward his Ph.D. at The University of Wisconsin, Dept. of Industrial Engineering

**Papers and Presentations:**

Meyer, R.H., "Research and Recent Ergonomic Developments in Prone Posture Workstations for Agriculture," ASAE Annual International Meeting in Ottawa, Ontario, August 2004.

**Proposals Submitted/Funded:**

None.

**Project #16**

Institution:	The University of Michigan
Core Area:	Industrial Hygiene
Research Trainee:	Peter Mancuso, Ph.D., Assistant Professor of Environmental Health Science
Title:	Alveolar macrophage responses to fine and ultrafine particles
NORA Area(s):	Asthma and Chronic Obstructive Pulmonary Disease, Exposure Assessment
Direct Cost Budget:	\$20,000
Funding Period:	June 2003-July 2004

**Abstract:**

This project is an important first step in understanding the characteristics of exposure, dose, and the adverse health effects associated with inhalable particulates finer than those contained within the particle size fractions embodied in current occupational aerosol standards. The objective of the research is to examine the interaction of alveolar macrophages with fine and ultrafine particles in order to identify the factors such as particle size and chemical composition that govern particulate uptake and subsequent inflammatory mediator synthesis. Specifically the project will (a) examine the interactions between insoluble particles (polystyrene microspheres) and murine alveolar macrophages *in vitro*, using the confocal microscopy to examine the uptake of particles of different sizes and chemical composition; and (b) correlate particulate uptake with the synthesis of pro-

inflammatory cytokines and leukotrienes that are relevant to health effects (such as exacerbations of asthma) known to be associated with exposures of humans to fine aerosols. The outcome of this research will be new experimental data that will begin to help elucidate the nature of how inhaled fine particles can produce inflammatory responses that might lead to the observed adverse health effects in exposed populations. Since no previous research has addressed *in vitro* the nature of the interactions in question at this level, the important distinctive roles of particle size and chemical composition remain unclear. An important outcome of the research will be the basis it will provide for a viable proposal for much larger external funding (e.g., one or more RO1s), to support far more extensive research both *in vitro* and *in vivo*.

**Current Position of Research Trainee:**

Dr. Mancuso is an Assistant Professor of Environmental Health Sciences at The University of Michigan.

**Papers and Presentations:**

None.

**Proposals Submitted/Funded:**

None.

**Project #17**

Institution: The University of Michigan  
Core Area: Occupational Medicine  
Research Trainee: Anne G. Hartigan, M.D., Clinical Instructor, Physical Medicine and Rehabilitation  
Title: Self-Assessment of Work Capability  
NORA Area(s): Musculoskeletal Disorders, Special Populations at Risk, Social and Economic Consequences of Work Injury  
Direct Cost Budget: \$20,000  
Funding Period: June 2003-July 2004

**Abstract:**

The ability to determine which job will match a person's capability has been problematic in the industrial environment and even more challenging for individuals with disabilities. Existing self-assessment tools address functional status through measures of activities of daily living, quality of life, general health, psychosocial factors or functional capacity evaluations, but few focus on specific work tasks. Through the use of a video-based self-assessment tool, we plan to quantify a worker's capabilities through comparison with ergonomic ratings. Specific aims include: 1) Test the validity and reliability of a self-administered worker functional assessment tool in a population with known low back or upper extremity MSDs; 2) Test sensitivity to detect a disabled population by comparing self-assessment data from a disabled population with existing data on a working, non-disabled population (N=79). Methods include recruitment of 50 subjects from University of Michigan clinics. Subjects will complete questions on the self-driven computer self-assessment tool including demographic data, visual analog scale for pain by body part, Short-Form 12, Oswestry questionnaire, Disability Assessment Shoulder Hand (DASH) and review a series of videos demonstrating different postures, forces and repetition. After watching a series of videos, subjects will use a VAS to rate how confident they are in performing the motion demonstrated. The instrument's validity will be tested on two levels: comparing individual responses to 1) ergonomic analysis of a series of standard

jobs, and on a subset, 2) ergonomic analysis of a subject's existing job. Internal consistency and reliability will be tested through randomization of repeat questions and videos throughout the tool. This pilot study may provide an efficient, inexpensive system in comparison to the traditional functional capacity evaluation (FCE) and translate into a prevention strategy which leads to an effective workplace intervention to place newly hired and returning workers with disabilities.

**Current Position of Research Trainee:**

Dr. Hartigan is a Clinical Instructor in the Department of Physical Medicine and Rehabilitation at The University of Michigan.

**Papers and Presentations:**

None.

**Proposals Submitted/Funded:**

None.

**Project #18**

Institution: The University of Michigan  
Core Area: Occupational Epidemiology  
Faculty Sponsors: Alfred Franzblau, M.D., W. Monroe Keyserling, Ph.D.  
Research Trainee: Jennifer Chang D'Souza, Ph.D. Student, Occupational Epidemiology  
Title: Expert Ratings of NHANES Occupational Categories  
NORA Area(s): Musculoskeletal Disorders, Exposure Assessment  
Direct Cost Budget: \$17,257  
Funding Period: June 2004-July 2005

**Abstract:**

Certain occupational activities such as stair climbing, heavy lifting and squatting have been frequently associated with knee osteoarthritis (OA), and are considered established risk factors for knee OA. However, the exposure data in these epidemiologic studies are frequently dichotomized, self-reported or based on job titles (Cooper, 1994; Maetzel et al, 1997; Schouten et al, 2002). These exposure assessment methods often do not take into account previous work history, do not represent a range of exposures and thus do not adequately characterize occupational exposures. These inadequacies represent a challenge in further describing the relationship between distinct occupational exposures and the later development of knee osteoarthritis (i.e., dose-response relationships, threshold effects), as well as developing effective interventions. An additional challenge in studying knee OA is the expense and difficulty in obtaining knee radiographs to validly assess the outcome. Anderson et al (1986) analyzed the association between knee radiographs and current occupation in The First National Health and Nutrition Examination Survey (NHANES I), which was a cross-sectional survey of the nation's health. Job categories were characterized by averaging the ratings performed by the Department of Labor (DOL) and published in the Dictionary of Occupational Titles (DOT). However the knee bending requirement variable was dichotomous and did not differentiate between various knee bending activities (e.g. stooping, kneeling, crouching or crawling). The strength variable was rated on a 5-point scale, but was dichotomized. The NHANES III is the most recent survey and contains important work history variables not included in NHANES I and bilateral knee radiographs. However, examining the relationship between the 40 occupation categories

in the NHANES III and knee OA is limited by the lack of sufficient exposure data for the job categories. In order to further describe these occupation categories beyond dichotomous variables used by Anderson et al (1986), the proposed project aims to develop job ratings for the occupation categories based on the consensus of ergonomic experts (aka Delphi survey). Ergonomic experts would individually rate the job categories on various physical variables associated with knee OA, and then come to a consensus rating through discussion with other experts. The hypotheses of the study address the following areas: 1) between- and within-expert rating variability of occupational categories 2) comparisons with the occupational ratings performed by the Department of Labor (DOL) and published in the "O\*NET Analyst" database.

**Current Position of Research Trainee:**

Ms. D'Souza has completed her Ph.D. in Occupational Epidemiology and is currently working at the Institute of Gerontology, at the University of Michigan.

**Publications and Presentations**

Jennifer C. D'Souza; Alfred Franzblau; W.Monroe Keyserling; Brenda Gillespie; Robert A. Werner. Occupational factors and Knee Osteoarthritis (OA): An analysis of the Third National Health and Nutrition Examination Survey (NHANES III) using Expert Ratings, 28<sup>th</sup> International Congress on Occupational Health, Milan, Italy, June 2006

Jennifer C. D'Souza; Alfred Franzblau; W. Monroe Keyserling; Brenda Gillespie; Robert A. Werner. Expert consensus ratings of occupational physical exposures, 28<sup>th</sup> International Congress on Occupational Health, Milan, Italy, June 2006

Jennifer C. D'Souza, Robert A. Werner, W. Monroe Keyserling, Brenda Gillespie, Randall Rouborn, Sheryl Ulin, Alfred Franzblau. Analysis of the Third National Health and Nutrition Examination Survey (NHANES III) using Expert Ratings of Job Categories, in preparation for AJIM.

Jennifer C. D'Souza, W. Monroe Keyserling, Robert A. Werner, Brenda Gillespie, Alfred Franzblau. Expert Consensus Ratings of Job Categories from the Third National Health and Nutrition Examination Survey (NHANES III), in Preparation for AJIM

**Proposals Submitted/Funded:**

Proposal to National Center of Health Statistics/ Research Data Center to release data on NHANES Subjects' specific job codes using 3-digit 1980 Census job codes. Proposal to release data accepted with no additional funding.

**Project #19**

Institution:	The University of Wisconsin
Core Area:	Safety and Ergonomics
Faculty Sponsor:	Robert G. Radwin, Ph.D.
Research Trainee:	Amrish Chourasia, Ph.D. Student, Biomedical Engineering
Title:	Comparison of biomechanical effects of eccentric and concentric exertions
NORA Area(s):	Musculoskeletal Disorders
Direct Cost Budget:	\$19,401
Funding Period:	June 2004-July 2005

**Abstract:**

Work place exertions may include muscle shortening (concentric), muscle lengthening (eccentric) or constant muscle length (isometric) contractions. Muscle injury may occur for any of these types of exertions depending upon the magnitude, repetition rate and duration of the contractions. However, eccentric contractions have been associated with higher damage than similar concentric contractions. Onset of muscle soreness, increased passive muscle stiffness, force decrements several days after intense eccentric contractions have been reported but not after concentric contractions of similar magnitude, repetition and duration. Changes in signal intensity and T2 relaxation time in MRI images have been seen after eccentric exercise but not after concentric exercise.

The human hand and arm have been modeled as a single degree of freedom mechanical torsional system and represented as a single mass, spring and damper. An instrument was developed in the Occupational Ergonomics and Biomechanics laboratory at the University of Wisconsin-Madison to quantify the dynamic properties of (stiffness, inertia and damping) of the hand-arm system. Previous studies have shown that the dynamic mechanical properties are dependent on the posture of the operator and location of the workspace. Reduced stiffness can cause greater reaction forces and handle displacement when using a power tool, adversely affecting the ability of a worker to operate one. Long-term effects of these findings in repetitive exercise are not yet known.

This study investigates the upper limb mechanical properties and magnetic resonance images (MRI) of the involved muscles following submaximal eccentric and concentric exertions. Twelve participants were randomly assigned to perform at 30° per second eccentric or concentric forearm supination exertions at 50% isometric maximum voluntary contraction (MVC) for 30 minutes. Measurement of mechanical stiffness, isometric MVC, localized discomfort and MRI supinator: extensor signal intensity ratio was done before, immediately after, 1 hour after and 24 hours after the bout of exercise. A 53% average decrease in mechanical stiffness after 1 hour was observed for the eccentric group ( $p < 0.05$ ) compared to a 1% average decrease for the concentric group ( $p > 0.05$ ). Both groups had significant reduction ( $p < 0.05$ ) in static strength following exercise but both groups had recovered to within 5% of pre exercise static strength. Edema, indicative of swelling, was observed 24 hrs after exercise, with an average increase in the MRI supinator: extensor signal intensity ratio of 36% for the eccentric group and less than 10% for the concentric group ( $p < 0.05$ ).

**Current Position of Research Trainee:**

Mr. Chourasia is currently a Graduate Student Research Assistant working toward his Ph.D. at The University of Wisconsin, Dept. of Biomedical Engineering.

**Papers and Presentations:**

Radwin, R.G., Chourasia, A.O., Sesto, M.E., Upper limb mechanical changes following simulated repetitive power tool use. 16th World Congress of the International Ergonomics Association Meeting, Maastricht, The Netherlands, July, 2006

**Proposals Submitted/Funded:**

None.

**Project #20**

Institution: The University of Michigan

Core Area: Industrial Hygiene  
Faculty Sponsor: Edward T Zellers, Ph.D.  
Research Trainee: Chunguang Jin, Ph.D. Student, Environmental Health Sciences  
Title: Chemometric Methods for Assessing Exposures to Indoor Air Contaminants with a Microanalytical System  
NORA Area(s): Indoor environments, Emerging technologies, Exposure assessment  
Direct Cost Budget: \$15,000  
Funding Period: June 2004-July 2005

**Abstract:**

The PI is currently engaged in research projects aimed at developing miniature instrumentation that couples tunable gas-chromatographic (GC) separations with microsensor array detection. The separation module consists of two series-coupled micro-columns whose retention characteristics can be tuned by use of pressure and temperature modulation. The sensor array comprises a set of chemiresistors (CR) with different gold-thiolate nanoclusters as sorptive interface layers whose output provides a pattern or "spectrum" that is characteristic of the vapor being detected. The hardware required to realize both "meso-scale" and "micro-scale" prototypes of such systems is well along toward development, however, the software has lagged behind. This project sought to develop multivariate statistical methods and other chemometric methods, to address critical modeling and data analysis functions needed to guide the development and allow the implementation of these novel instruments specifically for application in assessing exposures to indoor air contaminants. First, software routines were developed that combine algorithms for pattern recognition with retention time values to assign identities to chromatographically resolved and partially unresolved response signals (i.e., peaks) from the analyzer. The software routine has been successfully tested on sensitivity data set collected on a 3-sensor CR array detector. Next, a class model based on Mahalanobis distance was developed for evaluating the fidelity of the response patterns obtained from chromatographically resolved target vapors to the patterns for such vapors stored in a calibration pattern library, thereby establishing a means of assigning a statistical confidence level to the assignments of vapor identities when possible (uncalibrated) co-eluting interferences may be present. Then, in order to develop a method was developed for combining these sophisticated statistical methods with physico-chemical models of interactions between analyte vapors and both the column stationary phases and the microsensor interface layers for the purpose of assigning identities to unknown, previously uncalibrated analytes, retention models of a dual column was established, and response pattern data set was collected for more than 30 compounds to help with exploration of response model for CR sensors. Linear-solvation-energy relationship (LSER) models were employed as a very powerful and versatile tool for predicting responses and improving the reliability of analyses performed with such microsystems. The possibility of construction of a hybrid sensor array from TSMR sensors and capacitive sensors was also studied by math modeling and multivariate statistic analysis. This research has addressed on-going needs identified in the NIOSH National Occupational Research Agenda (NORA) in the areas of emerging technologies and exposure assessment methods.

**Current Position of Research Trainee:**

Mr. Jin is a Ph.D. candidate in Environmental Health Sciences at The University of Michigan

**Papers and Presentations:**

Jin, C. and Zellers, E.T., "Artificial Neural Networks for a Multi-Sensor  $\mu$ GC Detector: 'Limits of Recognition' For Simple Vapor Mixtures Determined with a Multisensor Array", Poster presentation, Engineering Research Center for Wireless Integrated MicroSystems on-site meeting, Ann Arbor, October 2004

Jin, C. and Zellers, E.T., "Pattern Recognition Techniques for VOC Detection by a Multi-sensor Array", Poster presentation, American Industrial Hygiene Conference & Exposure, Anaheim, May 2005

Jin, C. and Zellers, E.T., "Artificial Neural Networks for a Multi-Sensor Micro-GC Detector", Poster presentation, Engineering Research Center for Wireless Integrated MicroSystems on-site meeting, Ann Arbor, May 2005

Lu, C. J., Jin, C. and Zellers, E.T., "Chamber evaluation of a portable GC with tunable retention and microsensor-array detection for indoor air quality monitoring", *J. Environ. Monit.*, 2006, 8, 270-278

Jin, C, Kursawski, P, Hierlemann, A., Zellers, E. T., "Performance Analysis of a Multi-Transducer Vapor Sensor Array", manuscript in preparation

**Proposals Submitted/Funded:**

The work performed as part of this PPRT grant formed the basis for a component of this research.

Active/Funded:

Grant # 06-G-024

Transportation Security Administration-Dept. Of Homeland Security

E. Zellers, PI; C. Kurdak:, co-I

Au-Thiolate Nanoparticles as Interfacial Layers on Microsensor Arrays for Trace Explosive Vapor Detection

09/29/06 – 09/28/09

\$ 1,303,877 (TC)

**Project #21**

Institution: The University of Michigan

Core Area: Occupational Health Nursing

Research Trainee: Anne G. Thomas, Ph.D., Assistant Professor, Community Health Nursing

Title: Worksite Intervention to Promote Physical Activity

NORA Area(s): Special populations at risk, Intervention effectiveness research

Direct Cost Budget: \$8,300

Funding Period: June 2004-July 2005

**Abstract**

Sedentary behavior is identified as a strong risk factor for chronic disease and conditions including cardiovascular disease, diabetes, obesity, osteoporosis, colon cancer and depression. Increased physical activity (PA) is associated with improved cognitive performance, mood, body image, self-esteem, increased functional ability and the general feeling of psychological well-being (USDHHS, 1996). Unfortunately, more than 60% of American adults do not engage in regular PA (USDHHS, 2000). Since many employees working in an academic setting have mostly sedentary jobs, a behavioral lifestyle intervention delivered in a worksite setting is an effective strategy to reach this

group of adults who may not regularly participate in a PA within or outside of the work environment. However, there have been relatively few worksite interventions that designed to increase PA, specifically in the academic setting.

The purpose of this pilot project was to develop a worksite intervention to promote PA. Specific aims were to: 1) examine the influence of worksite PA cues on theory based variables (attitudes, behavioral beliefs, control beliefs, subjective norms, Perceived self-efficacy, intentions) and self-reported PA; 2) examine the impact of STEPS, a specific worksite PA program on PA behavior, blood pressure and body mass index, and 3) identify theory-based variables (attitudes, behavioral beliefs, control beliefs, subjective norms, perceived self-efficacy, intentions) that mediate effects of STEPS worksite intervention on participant's self-reported PA behavior.

Focus groups and a pre-post test design were used to develop and evaluate the effects of the worksite PA intervention. Participants were recruited from the faculty and staff at a School of Nursing in a Midwestern state. Twelve staff and seven faculty participated in the focus groups, 98 in answering the web-based survey in Phase II, and 58 in the 12 week STEPS intervention in Phase III.

Repeated analysis of variance (ANOVA) was used to examine the key variables in Aim 1. The STEPS intervention significantly increased behavioral and attitudinal beliefs related to worksite PA. Repeated ANOVA was used to examine Aim 2 with forty four out of the 59 subjects completing pre and post test measurements. Two findings were significant for the BMI post intervention: 1) younger aged subjects had higher BMI values, middle-aged subjects had lower values and the older age group remained the same and; 2) baccalaureate and doctorally educated subjects had higher BMI measures after the intervention while master's educated subjects had higher values pre-intervention. Time was marginally significant ( $p=0.062$ ) for decreases in systolic and diastolic blood pressure measurement. Preliminary examination of Aim 3 reveals an insufficient amount of data to adequately analyze mediating factors as related in the theoretical model.

Findings suggest promising results of a work-site intervention to increase walking at the work site. Decreases in self-efficacy suggest the need for stronger boosters throughout the intervention.

#### **Current Position of Research Trainee:**

Dr. Thomas is an Assistant Professor of Community Health Nursing at The University of Michigan.

#### **Papers and Presentations:**

Thomas, Anne G. "University Worksite Intervention to Increase Physical Activity, Proceedings: Midwest Nursing Research Society 30th Annual Research Conference, Milwaukee, WI, April 2006.

Thomas, Anne G. "Increasing Physical Activity in an Academic Work Environment: Focus Group Results," Proceedings: Midwest Nursing Research Society 30th Annual Research Conference, Milwaukee, WI, April 2006.

Thomas, Anne G. "Increasing Physical Activity in an Academic Setting: An Intervention for Faculty and Staff," International Congress for Occupational Health, Milan, Italy, June 2006 (abstract accepted, but not presented).

**Proposals Submitted/Funded:**

None.

**Project #22**

Institution: The University of Michigan  
Core Area: Ergonomics, Industrial Hygiene  
Faculty Sponsor: Thomas J. Armstrong, Ph.D.  
Research Trainee: Andrew Comai, Ph.D. Student, Environmental Health Sciences  
Title: Developing and testing guidelines for ergonomic assessment tools  
NORA Area(s): Musculoskeletal disorders, Exposure assessment methods  
Direct Cost Budget: \$20,000  
Funding Period: June 2004-July 2005

**Abstract:**

The primary goals of this project were to: 1) Determine the agreement between evaluators using different ergonomic assessment tools in different manufacturing sites, and 2) Develop basic application guidelines for different ergonomic assessment tools.

There are various ergonomic assessment systems used to describe worker exposure to risk factors for a given work station or activity. The project sought to develop basic guidelines for evaluators using different ergonomic assessment tools. Field trials are needed to compare the tools in different settings and develop guidelines on when and how each tool should be applied. This project compared several ergonomic risk factor assessment systems in real work environments using worker/evaluators.

Four evaluators were trained in the use of Rapid Upper Limb Assessment (RULA), Strain Index, and The Hand Activity Level Threshold Limit Value. One checklist, the UAW GM Risk Factor Checklist used in Delphi and General Motors was well known to the evaluators. For the most part evaluators, were not accustomed to the other checklists. The evaluators were deployed to three manufacturing facilities and asked to collect data on 10-15 jobs at each plant. The facilities selected for study varied in their work organization and product. At the time each job was analyzed with paper checklists, a video was taken. After each data collection a full day focus group was conducted to review video tapes and discuss how each evaluator scored jobs using each tool. The data collected and the discussions from focus groups demonstrate a learning effect as the evaluators became more comfortable with the tools.

In all, 336 ergonomic assessments on 28 jobs were conducted at 3 manufacturing facilities. Statistical analysis of data was performed with SAS:

- The average Strain Index was  $24.7 \pm 40.6$  out of a possible score of 1,053. Average plant scores for plants 1, 2 and 3 were  $8.6 \pm 60.0$ ,  $13.5 \pm 38.1$  and  $6.8 \pm 8.6$  respectively.
- The average RULA was  $6 \pm 1.3$  out of a possible score of 8. Average plant scores for plants 1, 2 and 3 were  $5.3 \pm 1.4$ ,  $6.2 \pm 1.1$  and  $6.4 \pm 1.1$  respectively.
- The average HAL was  $5.7 \pm 2.3$  out of a possible score of 10. Average plant scores for plants 1, 2 and 3 were  $7.5 \pm 2.4$ ,  $6.0 \pm 1.8$  and  $4.0 \pm 1.5$  respectively.

- The average Peak Force was  $3.5 \pm 2.1$  out of a possible score of 10. Average plant scores for plants 1, 2 and 3 were  $2.7 \pm 1.8$ ,  $3.2 \pm 1.8$  and  $4.5 \pm 2.3$  respectively.

Much of the variation that is captured by plant level statistics can be explained by a few jobs with special characteristics. The data collected and the discussions from focus groups demonstrate a learning effect as the evaluators became more comfortable with the tools.

### **Project #22**

Institution: The University of Michigan  
 Core Area: Ergonomics, Industrial Hygiene  
 Faculty Sponsor: Thomas J. Armstrong, Ph.D.  
 Research Trainee: Andrew Comai, Ph.D. Student, Environmental Health Sciences  
 Title: Developing and testing guidelines for ergonomic assessment tools  
 NORA Area(s): Musculoskeletal disorders, Exposure assessment methods  
 Direct Cost Budget: \$20,000  
 Funding Period: June 2004-July 2005

### **Abstract, continued:**

During this project potential sources of variance were identified. Environmental variability included changing work methods, operator anthropometry and the different nature of the plant production methods. Analytical variability included interpretations made by individual evaluators, and changes in tool collection methods across the plants. Applicator guidelines for multiple analysis tools were developed and refined for tools at each of the three sites.

### **Current Position of Research Trainee:**

Mr. Comai is a Ph.D. student in Environmental Health Sciences at The University of Michigan.

### **Papers and Presentations:**

None.

### **Proposals Submitted/Funded:**

A follow grant proposal to follow up on these findings was submitted to Michigan Interdisciplinary Center on Social Inequalities, Mind and Body (MICOSIMB), but was not funded. The proposed work included resampling job risk factors at plants involved in the initial study and expanding the study to several more locations.

### **Project #23**

Institution: The University of Michigan  
 Core Area: Industrial Hygiene  
 Faculty Sponsor: Edward T. Zellers, Ph.D.  
 Research Trainee: Kathryn Sensenig, Ph.D. Student, Chemistry  
 Title: A Microfabricated Diffusional Vapor Sampler with Integrated Thermal Desorption Heater  
 NORA Area(s): Indoor Environments, Emerging Technologies, Exposure Assessment Methods  
 Direct Cost Budget: \$19,750  
 Funding Period: June 2005-July 2006

**Abstract:**

The development of a passive microfabricated diffusional vapor sampler ( $\mu$ DVS) with integral thermal desorption heater, occupying a volume of  $\sim 0.15 \text{ cm}^3$ , is proposed. Advantage will be taken of the micron-scale dimensions of the device components to achieve high (pumpless) effective sampling rates, high preconcentration factors, and power-efficient desorption of ambient volatile organic vapors (VOCs). Performance will be assessed in light of theoretical models of diffusional transport and adsorption capacity. The device will be interfaced with a conventional photo-ionization detector as well as a microsensor array and subjected to chamber tests to document the quantitative capture, release, and detection of common indoor and workplace contaminants at ambient concentrations ranging from low-ppb to low-ppm with a duty cycle of  $\sim 1$ -15 minutes. Through this work, the feasibility of performing direct measurement of vapor exposures in occupational environments with such a microsystem will be demonstrated. Different, partially selective adsorbent materials will be tested to explore the possibility of using an array of samplers within a single module for broad-based vapor monitoring. If these preliminary tests are successful, this diffusive sampler design could be adapted for incorporation into the next prototype micro-gas chromatograph ( $\mu$ GC) being developed in an on-going parallel effort funded through the Michigan Center for Wireless Integrated Microsystems (WIMS) in which the PI and co-PI are involved. This research will address needs identified as NIOSH NORA research priorities in the areas of indoor environments, emerging technologies, and exposure assessment methods.

**Project #24**

Institution:	The University of Michigan
Core Area:	Ergonomics and Safety
Faculty Sponsor:	Thomas J. Armstrong, Ph.D.
Research Trainee:	Michael Lau, Ph.D. Student, Industrial and Operations Engineering
Title:	Investigating the effect of parallax on upper limb posture analysis
NORA Area(s):	Musculoskeletal disorders, Exposure assessment methods
Direct Cost Budget:	\$19,250
Funding Period:	June 2005-July 2006

**Abstract:**

Observational methods are widely used to estimate work postures for application of job analysis tools used to evaluate stresses associated with hand and wrist musculoskeletal disorders. Often, observations for these methods, which include RULA, OWAS, VIDAR, Strain Index, ACGIH TLV for HAL, REBA, and GM-RFCII, are made retrospectively from video recordings. Available studies show that these estimates may be subject to significant error (Lowe, 2004). The aim of this study is to investigate factors that affect the accuracy and precision of wrist posture estimates based on observations from video recordings. Specific factors include parallax, image size and hand postures.

The effect of parallax on the angle between two intersecting lines can be easily computed and show that the perceived angle changes as a tangent function of the viewing angle. Unless the camera or observer is perfectly aligned with the axis of rotation, there will always be parallax. As a practical matter, it is almost impossible to not have some parallax error for wrist postures; an aspect seldom accounted for in existing literature.

The hand is a solid object, not simply two intersecting lines. The surfaces of the hand have shape, texture and color that provide visual queues that can help observers compensate for parallax. We believe that while these cues assist in posture estimation, they are insufficient to eliminate the effects of parallax.

This project has two aims. First, we will systematically investigate the effect of camera angle, image size and hand posture on observer estimates of static wrist postures. Second, we will determine the effect recording angle has on observer identification of peak and awkward postures in repetitive dynamic wrist motions. We will attempt to relate the findings to relevant risk assessment tools. This project will lay important foundations for research that examines the way ergonomic data are collected; the long term goal being to create a standardized approach to the recording and use of video data. Results can be used to develop preliminary correction factors to reduce observational error introduced by non-ideal video recording angles. Results may also prompt ergonomics researchers to begin reporting video capture methods so that results may be interpreted more carefully. By reducing exposure assessment error, the results will lead to improved exposure-response models and will help practitioners make fewer errors identifying workplace stresses and problematic jobs.

### **Project #25**

Institution: The University of Michigan  
Core Area: Ergonomics and Safety  
Faculty Sponsor: Thomas J. Armstrong, Ph.D.  
Research Trainee: Jaewon Choi, Ph.D. Student, Industrial and Operations Engineering  
Title: Development of a Biomechanical Hand Model for Study of Hand Posture, Strength, and Musculoskeletal Disorders  
NORA Area(s): Musculoskeletal Disorders, Exposure Assessment Methods  
Direct Cost Budget: \$16,450  
Funding Period: June 2005-July 2006

### **Abstract:**

This study will develop a biomechanical model of the hand that can be used to predict posture and strength for manual work tasks and also predict tendon loads and displacements. There have been numerous epidemiological studies to relate risk factors to work-related musculoskeletal disorders of upper extremities. These risk factors are closely associated with biomechanical stresses on specific parts of upper extremities. Therefore, understanding and applying biomechanical aspects of risk factors to actual workspace will be helpful in assessing and preventing exposure to the risk factors.

In this study, a model of finger motion will be developed for selected tasks so that it can be used to develop models of muscle shortening and to determine the role of active and passive forces in closing the fist. The resulting model will also be applied to selected jobs to determine tendon forces and movements in selected jobs known to have high and low risk of hand-wrist tendonitis.

Future studies will examine dose-response relationship between tendon loads and chronic tendon injuries of the hand and wrist.

The results of this study will be an important tool for persons design manual tasks and to persons concerned with evaluating and controlling risk of work related musculoskeletal disorders.

### **Project #26**

Institution: The University of Michigan  
Core Area: Occupational Health Nursing  
Faculty Sponsor: Oisaeng Hong, Ph.D.  
Research Trainee: Ae Suk Jeong, Ph.D., Post-Doctoral Research Fellow, Community Health Nursing  
Title: Occupational Exposure, Knowledge and Protective Behaviors Among Korean Dry Cleaners  
NORA Area(s): Special Populations at risk, Mixed Exposures  
Direct Cost Budget: \$16,050  
Funding Period: June 2005-July 2006

### **Abstract:**

Health and safety hazards in dry cleaning workers have been identified by scientists in the National Institute for Occupational Safety and Health (NIOSH) and other researchers. Despite study results highlighting the alarming risks and hazards in the dry cleaning industry, studies on understanding workers' knowledge of safety and health hazards and their occupational health protection behaviors are limited.

The purpose of the project is to assess health risks and protective behaviors among Korean drycleaners. Three specific aims will be addressed in this study: (1) assess knowledge of occupational exposure and health effects; (2) identify stages of protective behavioral change; and (3) determine prevalence of occupational injuries and risks among Korean drycleaners.

The proposed study will utilize both qualitative (focus groups) and quantitative (survey) approaches to meet specific aims. Study participants will be recruited from the Federal Korean Drycleaners Association members in Michigan. Results from this study will provide important preliminary data for developing educational intervention strategies to prevent occupational injuries and illness among Korean drycleaners.

### **Project #27**

Institution: Purdue University  
Core Area: Occupational Safety  
Faculty Sponsor: Shirley Rietdyk, Ph.D.  
Research Trainee: Christopher Rhea, Ph.D. Student, Health and Physiology  
Title: Gait Adaptations: Role of Visual Information and Repeated Exposures in Risk Assessment of Tripping for Construction Workers  
NORA Area(s): Traumatic Injuries, Risk Assessment Methods  
Direct Cost Budget: \$13,385  
Funding Period: June 2005-July 2006 (original)  
January 2006-December 2006 (carryover with no-cost extension, completion date extended due to late start and equipment problems)

**Abstract:**

Slips, trips, and falls are a major contributor to injuries in the construction industry. While recent research has found that industry workers adequately perceive the risk of slipping on a surface, the risk of tripping over obstacles has not been investigated. Toe clearance, a quantity of the risk of tripping, increases from level walking to stepping over obstacles and further increases with visual interference. Construction workers navigate a cluttered environment where obstacles are frequently in their walking path. In addition, construction workers regularly carry objects that obstruct their view of the ground and a potential obstacle. This project will investigate if construction workers can accurately perceive various obstacle heights and will assess the risk of tripping based on perception-action theory. Also, this project will attempt to identify if construction workers have developed different obstacle crossing strategies compared to non-construction workers. This project addresses the National Occupational Research Agenda (NORA) Priority Research Areas: Traumatic Injuries and Risk Assessment Methods. Research outcomes will potentially identify strategies for avoiding tripping hazards thus reducing injuries and fatalities from such hazards in the construction industry. Results from this pilot research will enable future project proposals that will identify risk factors and prevention strategies for falling from tripping in cluttered construction environments.

**Project #28**

Institution: The University of Michigan  
Core Area: Industrial Hygiene  
Research Trainee: Chuanwu Xi, Ph.D., Assistant Professor, Department of Environmental Health Sciences  
Title: Microbial Characterization of Metal Removal Fluids and Associated Biofilms Using Molecular Approaches  
NORA Area(s): Infectious Diseases, Indoor Environments, Exposure Assessment Methods, Asthma and Chronic Obstructive Pulmonary Disease  
Direct Cost Budget: \$15,400  
Funding Period: July 2006-June 2007

**Abstract:**

Each year, billions of gallons of metal removal fluids (MRFs) are consumed in manufacturing for purposes such as metalworking (e.g., cooling and lubrication), surface preparation (e.g., cleaning and pickling), and finishing (e.g., coating and plating). A number of human health effects have been associated with exposure to MRFs, including various respiratory diseases, skin conditions, and cancers. It has become clear that the growth of microorganisms in MRFs may cause health hazards to workers. Several molecular techniques have been developed for the purpose of characterizing microorganisms in MRFs; however, no comprehensive study of microbial communities in MRFs has been reported yet. In this pilot project, we will develop and validate different molecular techniques for microbial characterization of MRFs samples. We will use the validated molecular methods to characterize microbial composition in detail in MRFs and to quantify the abundance of *Mycobacteria*, specifically *M. immunogenum* and Pseudomonades in MRFs environments including bulk fluids, biofilms and possibly bioaerosols to elucidate a possible critical role of biofilms in the microbial ecology in MRFs.

**Project #29**

Institution: The University of Michigan  
Core Area: Industrial Hygiene

Research Trainee: Simone Charles, Ph.D., Post-doctoral Research Fellow,  
Department of Environmental Health Sciences  
Faculty Sponsor: Stuart Batterman, Ph.D., Professor, Department of Environmental  
Health Sciences  
Title: Post-doctoral Training in Exposure Assessment of Emerging  
Contaminants in the Indoor Environment  
NORA Area(s): Indoor Environments, Exposure Assessment Methods  
Direct Cost Budget: \$20,000  
Funding Period: July 2006-June 2007

**Abstract:**

Brominated flame retardants (BFRs) such as polybrominated diphenyl ethers (PBDEs) and biphenyl are widely used in plastics, textiles, foams and electronic equipment. These contaminants are of great concern as body burdens are increasing at an exponential rate in both occupationally-exposed workers and in the general public. The emission sources and transport pathways that cause these exposures are poorly understood, particularly in the workplace. The available but limited measurements show that indoor concentrations of BFRs are high and greatly exceed outdoor levels. Because indoor and workplace environments are known to contain these materials, and since indoor levels appear to accumulate due to the presence of these sources and the slow rate of degradation, industrial and commercial buildings may represent an important exposure source. To date, however, the literature contains few occupational exposure studies that have characterized BFRs, and all of the identified studies have been conducted in Europe, though much higher exposures have been reported in North America. The proposed research aims to better understand occupational exposures of BFRs by characterizing their distribution and emissions in both commercial and industrial buildings. Emissions from indoor materials will be quantified by measuring vapor and particulate phase BFR-related compounds at 12 industrial and 12 commercial sites. At each site, we will measure incoming (outdoor) and exiting (indoor) BFR concentrations; determine air exchange rates using tracer gas techniques; assess building volume and other building parameters; and conduct a building walkthrough audit. Emission rates will be derived from the collected data by mass balance. Complementary but separate work will characterize these compounds in residential environments for comparison.

**Project #30**

Institution: The University of Michigan  
Core Area: Occupational Safety and Ergonomics  
Research Trainee: NaJin Seo  
Faculty Sponsor: Thomas J. Armstrong, Ph.D., Professor, Department of Industrial  
and Operations Engineering  
Title: Development of a Biomechanical Model for Torque and Thrust  
Strength on Cylindrical Handles  
NORA Area(s): Musculoskeletal Disorders of the Upper Extremity, Traumatic  
Injuries  
Direct Cost Budget: \$19,360  
Funding Period: July 2006-June 2007

**Abstract:**

The aim of this work is to develop models for predicting the capacity of the hand to apply torque and thrust force about and along the long axis of cylindrical handles. More specifically, this work will develop a biomechanical model of isometric or "quasi

isometric" torque and thrust force that can be exerted on cylindrical handles of a given diameter and surface friction when gripped at a given angle.

Our proposed biomechanical model and preliminary research show that torque strength about the long axis of a cylindrical handle is greater when torque is applied in the direction of the fingers than in the direction of the thumb.

The proposed study will 1) validate the biomechanical model for various handle materials. It will also examine 2) the effect of torque on pushing and pulling along the long axis of the handle and 3) the effect of grip force on wrist flexion and extension strength. In addition, the coefficient of friction will be measured for different parts of the hand with different normal force levels and handle materials.

The models developed in this study can be used to establish force design limits for work tasks that will accommodate desired percentiles of the male and female population. They also can be used to design equipment that minimizes force requirements, localized fatigue and the risk of work-related musculoskeletal disorders.

### **Project #31**

Institution: The University of Michigan  
Core Area: Occupational Safety and Ergonomics  
Research Trainee: Sarah Womack  
Faculty Sponsor: Jeffrey K. Liker, Ph.D., Professor, Department of Industrial and Operations Engineering  
Title: Modeling the Relationship between Work-related Musculoskeletal Disorder Risk Exposure and Lean Manufacturing  
NORA Area(s): Musculoskeletal Disorders of the Upper Extremity, Organization of Work  
Direct Cost Budget: \$14,300  
Funding Period: July 2006-June 2007

### **Abstract:**

This project examines the effects of lean manufacturing practices on work-related musculoskeletal disorder (WMSD) risk exposure. Japanese Management Systems have come under scrutiny because some believe that lean production methods increase the prevalence of WMSD injuries compared to traditional management systems.

Two studies will be conducted to:

1. Determine if there is a difference in the organization of work between exemplar lean and quasi-lean work sites.
2. Determine if there is a direct and measurable relationship between lean manufacturing practices and WMSD risk exposure
3. Gain insight into how the exemplar lean organizations manage and integrate productivity, ergonomics, and safety

To investigate the degree of leanness, the lean factors that will be examined at the plant level for both studies include quality, inventory, workforce flexibility and involvement in problem solving. Lean factors at the job level include wasteful motions in the job cycle such as walking, waiting, and unnecessary handling of parts and tools. The WMSD factors that will be evaluated include forceful exertions, repetition, and awkward postures of the wrist, shoulder and trunk.



**Appendix PPRT – 7.  
Summary of Funded Pilot Projects – Next Budget Year (2007-08)**

**FUNDED PROJECTS**

*Note: Project numbers are based on the serial number of all funded pilot projects. During the first seven years (July 1999-June 2006), we funded 31 projects. The beginning number for the 2007-08 funding cycle is #32.*

**Project #32**

Institution: The University of Michigan  
Core Area: Industrial Hygiene  
Research Trainee: Qiongyan Zhong, Doctoral Candidate in Industrial Health, Environmental Health Sciences, School of Public Health  
Title: Adaptation of a Novel Portable GC to the Determination of Breath Biomarkers of Lung Cancer  
NORA Area(s): Indoor Environments, Exposure Assessment Methods, Cancer Research Methods  
Direct Cost Budget: \$16,407  
Funding Period: July 2007-June 2008

**Abstract:**

This proposal seeks funding to adapt a high-performance portable gas chromatograph, containing several novel design and operating features, to the determination of volatile organic compounds in human breath that have been identified in several studies as potential biomarkers of lung cancer. Although resurgent interest in this non-invasive bio-monitoring technique is evident from the literature, current approaches rely on large, expensive instruments that are not suitable for untrained persons or on so-called 'electronic noses' (i.e., stand alone multi-sensor arrays) that generally lack sufficient resolution to provide reliable results. The research proposed here will explore the feasibility of monitoring breath biomarkers that have been associated with a specific disease, lung cancer, at clinically relevant concentrations in actual breath samples. Lung cancer is the leading cancer killer in both men and women, and the most frequent occupational cancer. Detection and treatment of lung cancer at an early stage can increase the 5- year survival rate greatly. Having a portable, turn-key instrument capable of identifying and quantifying lung cancer biomarkers would provide a means of screening workers at low cost in a matter of minutes in a field or clinical setting. This instrument is about the size of a laptop computer and incorporates state-of-the-art features, including a multi-stage preconcentrator, series-coupled separation columns with pressure and temperature tunable retention, and a detector comprising an integrated array of chemiresistor (CR) microsensors that provides a digital "spectrum" of eluting vapors. Its use for the determination of ppt levels of two environmental tobacco smoke markers in a complex mixture of prominent co-contaminants has recently been demonstrated. This project will determine its feasibility for the more challenging problem of identifying and quantifying lung cancer biomarkers in breath. This will be achieved by developing sampling/preconcentration methods to achieve desired detection limits while also rejecting or compensating for background humidity, establishing conditions for separating biomarkers from other endogenous and exogenous interfering compounds, calibrating the sensor arrays, and applying chemometric techniques tailored for this particular problem to confirm method reliability. Finally, the instrument will be tested with actual breath samples, and performance will be assessed through side-by side tests with GC-MS.

### **Project #33**

Institution: The University of Michigan  
Core Area: Hazardous Substance Academic Training  
Research Trainee: Jo-Yu Chin, Ph.D. Student, Environmental Health Sciences,  
School of Public Health  
Faculty Sponsor: Stuart Batterman, Ph.D., Professor, Department of Environmental  
Health Sciences  
Title: Pilot Project Research Training in Emission and Permeation  
Characteristics of Biofuels: Potential for Worker Exposure  
NORA Area(s): Indoor Environments, Exposure Assessment Methods  
Direct Cost Budget: \$19,870  
Funding Period: July 2007-June 2008

#### **Abstract:**

Biofuels such as bioethanol and biodiesel have the potential to reduce greenhouse gas (GHG) emissions and recently have emerged as the leading alternative fuel to replace fossil fuels in the transportation sector. The nature and production of biofuels have several different characteristics from conventional fuels that affect their potential for inhalation and dermal exposure in workplace setting. For example, bioethanol-gasoline mixtures tend to have higher evaporative emissions due to higher vapor pressure and greatly enhanced permeability. The proposed pilot project is aimed at (1) enhancing information regarding the emission profiles of biofuels, (2) understanding the permeability of biofuels through different elastomers and materials used in personal protection equipment (PPE) and biofuel production/distribution equipment, and (3) evaluating respiratory exposures of employees at biorefinery plants. The proposed work will support laboratory studies of volatilization and permeability, field sampling to characterize biofuel vapors in working areas at one or two biorefinery facilities, data analysis and manuscript/proposal preparation. The sampling and analysis procedures will utilize the state-of-the-art methods (active/passive sampling, multibed solid adsorbents, thermal desorption, gas chromatography and mass spectroscopy). Findings of this project will provide information for estimating occupational exposures at the several hundred biofuel production facilities operating or being constructed, most of which are in the Midwest region, and preliminary information for determining the need for emission controls or other interventions. This pilot project is closely related to several NORA priority areas, including emerging technology, indoor environment and exposure assessment (with applications in the manufacturing, transportation and fuel cycle areas), and exposure mixtures.

### **Project #34**

Institution: The University of Michigan  
Core Area: Hazardous Substance Academic Training  
Research Trainee: Chunrong Jia, Post-Doctoral Scientist, Environmental Health  
Sciences, School of Public Health  
Faculty Sponsor: Stuart Batterman, Ph.D., Professor, Department of Environmental  
Health Sciences  
Title: High Resolution Breath Monitoring of VOC Mixtures  
NORA Area(s): Exposure Assessment Methods, Mixed Exposures  
Direct Cost Budget: \$19,877  
Funding Period: July 2007-June 2008

**Abstract:**

Occupational exposures to mixtures of airborne volatile organic compounds (VOCs) must be characterized and understood to protect workers' health and improve the quality of exposure measures used in epidemiologic studies. Improved approaches are needed that provide rapid and comprehensive assessment of exposures, including mixtures. Breath sampling provides a convenient, noninvasive and flexible approach to measure exposure to many chemicals, including mixtures. Moreover, it measures the internal exposure, and thus provides a more realistic basis for exposure and risk assessment. To date, existing approaches for breath monitoring have not provided the consistency and performance desired and, despite calls from OSHA to account for exposures to mixtures, there are few studies that have characterized mixtures using breath monitoring. The objective of the proposed pilot research project is to improve breath monitoring instrumentation and to demonstrate its application to VOC mixtures in occupational settings. We will refine and demonstrate an existing and innovative prototype breath sampling system that features collection of alveolar samples without a special breath maneuver, the capability of monitoring a wide range of VOCs, and high performance (sensitivity and specificity). After laboratory testing, the system will then be used to collect breath samples from workers in two occupational settings. Indoor and outdoor samples will be obtained simultaneously. The collected data will be used to characterize occupationally related exposures to VOC mixtures and to apportion the sources of VOC exposures using the alveolar gradient approach. The pilot study results will demonstrate the capability of using breath monitoring in settings with complex exposures, and will be used to seek further support in characterizing exposure to toxic VOCs. The proposed research represents a priority area in the National Occupational Research Agenda with respect to developing appropriate methods for measuring biomarkers of exposures or diseases to improve the health of workers in indoor environments.

**Project #35**

Institution: The University of Michigan  
Core Area: Occupational Safety and Ergonomics  
Research Trainee: Sung Kyun Park, Sc.D., M.P.H., Research Professor,  
Environmental Health Sciences, School of Public Health  
Faculty Sponsor: Howard Hu, M.D., Sc.D., MPH, Professor and Chair,  
Environmental Health Sciences  
Title: Noise, Lead and Age-Related Hearing Loss  
NORA Area(s): Hearing Loss, Indoor Environments, Exposure Assessment  
Methods, Mixed exposures  
Direct Cost Budget: \$17,300  
Funding Period: July 2007-June 2008

**Abstract:**

Although hearing loss is one of the most profound common disabling conditions that older adults can suffer and has remained one of the top priorities on the U.S. NIOSH National Occupational Research Agenda (see: <http://www.cdc.gov/niosh/programs/hlp/>), it is substantially underestimated and its biological mechanism is poorly understood. The goal of this proposed pilot project is to examine whether noise and lead have a joint effect on hearing threshold among community-residing elderly men. This study will implement a NIOSH generated job-exposure matrix to estimate historical noise exposure. Understanding links between noise and lead exposures and age-related hearing loss informs efforts to prevent and reduce the burden of the disease. This study will take advantage of the data from a large, well-phenotyped, on-going, longitudinal

cohort, the Normative Aging Study including preliminary analyses demonstrating that K-x-ray fluorescence measured bone lead levels (a novel indicator of cumulative exposure) is associated with audiometric evidence of significant hearing loss. This pilot project will not only generate additional preliminary results for a future longitudinal prospective study but also suggest preventive public health strategies to prevent or delay the incidence of hearing impairment.

**Project #36**

Institution: The University of Wisconsin  
Core Area: Occupational Safety and Ergonomics  
Research Trainee: Robert S. Howery, Research Assistant, Biomedical Engineering  
Faculty Sponsor: Robert G. Radwin, Ph.D., Professor, Biomedical Engineering  
Title: Controlling Power Hand Tool Reaction Through Mechanical and Electronic Torque Control  
NORA Area(s): Musculoskeletal Disorders of the Upper Extremity  
Direct Cost Budget: \$20,000  
Funding Period: July 2007-June 2008

**Abstract:**

A significant number of occupational injuries are caused by repetitive use of industrial power hand tools, particularly nutrunners. While many tool manufacturers claim to design "ergonomic" industrial power tools, few designs consider how the torque applied to the fastener is actually transmitted to the operator. An ideal tool is one that will effectively perform a task, and have properties that minimize stressful forces. This study seeks to evaluate how changing the motor controller characteristics of a fastening power hand tool and the torque buildup function affects the forces acting against the operator, and the subsequent motions in reaction to these forces. Computer simulations of the dynamic system including an electromechanical model of the tool coupled with a biochemical model of the operator will be performed. These simulations will consider different types of torque inputs (constant, ramp up, ramp down, impulse) that are most likely to reduce reaction forces applied to the operator. An electric power hand tool will be modified specifically for this experiment. Twenty volunteer subjects that have limited or no experience using power hand tools will be recruited for this study. Subjects' biomechanical dynamic system parameters will be measured using an upper limb dynamic stiffness testing apparatus. All subjects will then perform multiple fastening operations under various tool physical conditions, torque inputs, and fastening joint stiffness levels. Data such as torque applied to the fastener and deflection of the tool handle will be collected for analysis and compared to the computer models of the biomechanical dynamic system. The experimental conditions that have the greatest effect on reducing reaction forces and motions on the operator will be identified. This research will serve as a pilot study for Mr. Robert Howery's doctoral thesis to further develop upper extremity biomechanical models for use with power hand tool design.